# Modelling eating behaviours:

# From childhood to adolescence

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# Abstract

This thesis aimed to explore the relationships between predictors[1] of eating behaviours in both childhood and adolescence and investigate their influence on food choice and food intake. For this, a global approach was used integrating individual, social and environmental predictors. The data included 210 participants aged 6-8 years old and 303 at the age of 12-13 of the Gateshead Millennium Study.

Section II (*Food intake in childhood*) aimed to explore the relationships between predictors (e.g. trying and liking fruits and vegetables, parents' food intake, etc.) and how they influence food intake in childhood (6-8 years old). Higher intake of healthy food was directly associated to liking fruits/vegetables and lower deprivation level, whereas higher intake of unhealthy was directly associated to lower level of liking fruits and lower BMI.

Section III (*Food choice and food intake in adolescence*) aimed to explore the relationships between predictors (e.g. intention and temptation to eat healthy and unhealthy food, inhibitory control, etc.) and how they influence food choice and food intake in adolescence (12-13 years old). Temptation was the strongest predictor of the food choice, whereas inhibitory control was the only predictor of healthy intake. None of the predictors influenced unhealthy intake.

Section IV *(Longitudinal analysis*) aimed to explore how food intake and its predictors in childhood influence eating behaviours and their predictors in adolescence. Tracking was weak in unhealthy intake and moderate in healthy intake. Several relationships between predictors from childhood influencing directly or indirectly eating behaviours in adolescence were found.

This thesis gives some evidence of the complexity of eating behaviours in childhood and adolescence. Some limitations and implications for practice and future research are discussed.


[1] The term *predictor* will be used in order to facilitate reading. However, it is important to highlight that the analysis of this thesis cannot imply any causality assumption. Only associations between the variables assessed can be established.

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## Presentations at conferences

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# SECTION 1

# INTRODUCTION

# Chapter 1.1 Thesis Introduction

### 1.1.1 Background

There is a consensus that the physical and cognitive development of children and adolescents is dependent on their nutrition. Over the last years, fruit and vegetable (FV) intake has been largely described as health protective (Boeing et al., 2012; He, Nowson, & MacGregor, 2006; Vainio & Weiderpass, 2006; WHO, 2002). In 2003, the World Health Organization (WHO - 2003a) recommended the intake of at least 400g of FV per day in order to prevent chronic disease. However, not many people meet these guidelines (Health and Social Care Information Centre, 2015) and research with children and adolescents reveals a similar pattern (Bates, Lennox, Prentice, Bates, & Swan, 2011; Health and Social Care Information Centre, 2015; Vereecken, Ojala, & Jordan, 2004). In an attempt to increase the levels of FV intake many countries adopted specific public health targets and "5-a-day" programmes were widely implemented to promote the intake of 5 FV per day (WHO, 2003b). Recent research, across 33 countries (mainly from Europe and North America), focusing on the intake of FV in adolescents found that, despite an increase in consumption levels observed between 2002 and 2010, a large proportion of participants still reported not eating FV on a daily basis (ranging from 51% to 85% for fruits and from 45% to 80% for vegetables) (Vereecken et al., 2015). In the UK, only around 16% of boys and 17% of girls eat five or more portions of FV per day (Health and Social Care Information Centre, 2015). To add to this picture, Piernas and Popkin (2010) analysed trends of snacking among 31337 children and adolescents aged 2–18 from four U.S. representative surveys on food intake. Their results revealed that the intake of sweets and savoury snacks increased significantly from 1989–91 to 1994–98 and again from 1994– 98 to 2003–06. Low FV consumption paired with a higher consumption of sweet and savoury snacks indicate a worsening in terms of healthy eating behaviour during childhood and adolescence.

This thesis will focus on two eating behaviours: *food choice* and *food intake* of FV and sweet/savoury food since they are important predictors of obesity in children and adolescents (Rennie, Johnson, & Jebb, 2005) and have also been identified as strongly associated with obesity in adults (Swinburn, Caterson, Seidell, & James, 2007).

The purpose of this work is to understand what factors influence eating behaviours in children and adolescents.

This chapter aims to introduce the rationale for the chosen predictors of eating behaviours in young people used in this thesis and to outline the general aims of the current work. In the next sections of this introduction, further details are discussed on behaviour theories used, so far, to explain and predict eating behaviours: 1) in childhood; 2) in adolescence; and finally, 3) in the transition between childhood and adolescence.

### *Predicting eating behaviours: The role of theories*

Behavioural and ecological theories have brought useful insights on how eating behaviours are influenced and shaped. Dahlgren and Whitehead (1991, 2007) suggested a model of "Main determinants of Health" postulating that health behaviours are influenced by multilevel factors. In the centre of the model the non-modifiable individual characteristics (e.g. age, sex) can be found. Dahlgren & Whitehead (1991) pointed out that that specific actions (e.g. policies) can go a long way in circumventing potential limitations associated with age and sex (e.g. policies on equality and diversity inclusion). After this core, distinct levels can be found. The first level includes personal behaviours (e.g. eating behaviours). The second level refers to social interactions (peers and immediate community) and the third level includes living and working conditions (access to food, healthcare, education, work environment, etc.). Surrounding the three previous levels, the authors refer to a macro-level including general socio-economic, cultural and environmental conditions of the society. This model is part of the ecological perspectives suggesting

that factors from different levels interact between each other influencing health (Dahlgren & Whitehead, 1991, 2007). Indeed, ecological perspectives on health behaviours (Sallis, Owen, & Fisher, 2008) acknowledge health as highly influenced by several factors at different levels: individual, social, environmental and policy influences (Sallis et al., 2008). According to these approaches, there are four core principles to understand health behaviours: 1) factors in multiple levels influence health behaviour; 2) factors interact across different levels; 3) behaviour change interventions should be more effective when targeting multiple levels; and, finally, 4) ecological models should be behaviour-specific, since each health behaviour is influenced by specific predictors (e.g. food preferences influences eating behaviours, but probably not physical activity). For instance, children tend to choose their food according to their past experience (Wardle, Sanderson, Leigh Gibson, & Rapoport, 2001) and preferences (De Bourdeaudhuij et al., 2008) – individual factors. However, other level factors are important to be considered at this stage of life. Parents are important models and their eating patterns can influence their child's eating behaviours (Pearson, Biddle, & Gorely, 2009) – social factors – and FV availability at home supports healthy choices contributes to child's healthy eating (Neumark-Sztainer, Wall, Perry, & Story, 2003) – environment factors. These different levels interact, that is, parents' intake influences food availability at home and this will then influences the child's preferences. This example shows the complexity of eating behaviours with many factors interacting and influencing these behaviours.

Over the last two decades, social cognitive theories (e.g. Ajzen, 1991; Bandura, 1978; Fishbein & Ajzen, 2010) have been widely used to study factors influencing eating behaviours. These theories have mainly focused on individual level factors including very few from a wider social level (although acknowledging the relevance of these and other factors). Briefly, these theories imply that behaviours result from beliefs. These beliefs will allow people to evaluate pros

and cons of engaging with a specific behaviour, emphasizing the relevance of perceived social influences as well as the individuals own evaluation of efficacy and control.

Few studies have tested these theories in young people (McClain, Chappuis, Nguyen-Rodriguez, Yaroch, & Spruijt-Metz, 2009).This might be due to the low predictive power of such theories when assessing young people (McEachan, Conner, Taylor, & Lawton, 2011). A meta-analyses (McEachan et al., 2011) on prospective studies predicting health-related behaviours using the Theory of Planned Behaviour (TPB) found 14 studies related to eating behaviours in adults (*N* = 3011) and 3 in adolescents (*N* = 3333). The results revealed that eating behaviours were less predicted in samples including adolescents when comparing with adult samples (9.6% vs. 26.7%, respectively).

Although the TPB has been largely used and contributed to psychological research over the last 20 years, it has also endured some criticism. Indeed, this theory assumes that most behaviour is goal-directed, suggesting that human behaviours are guided by intentions. However, not all intentions are carried out, pointing to one of the limitations of these theories, the intention-behaviour gap (Sheeran & Orbell, 1999). Sniehotta, Presseau and Araújo-Soares (2014) criticised particularly, the validity and utility of the TPB (Ajzen, 1991) pointing out several limitations such as : 1) TPB has not been effective in predicting future behaviour; 2) the TPB is over focused on cognitions disregarding the role of affects/emotions; 3) the TPB tests an analytic truth, i.e., the model is truth by definition and so, its hypotheses cannot be falsified; and, finally, 4) the TPB has exclusively focused on rational/reflective predictors.

For a long time the dominant health behaviour theories have focused on rational/reflective correlates of behaviours which limit the understanding on decision-making behaviours. The theory of “bounded rationality” suggested by Simon (1955) was one of the first recognizing that human decision making can be biased by the

information available in a specific time and environment (see Kahneman, 2003 for a review on biases and heuristics). This theory implied that, in a specific situation, people select the first option that satisfies their basic requirements instead of assessing all possible options to optimize the choice.

More recently, Prime Theory (West, 2006) suggested that people act in line with what they want and need in a specific moment. According to this theory, behaviour is influenced by plans and evaluations of the behaviour (reflective processes). However, these processes need to generate impulses/inhibitions sufficiently strong to create motives (feelings of want or need) at the specific moment to overcome competing feelings arising from internal states (such as drive states) and external triggers and cues. Indeed, people do not always make rational decisions and may be influenced by impulsive factors (Sheeran, Gollwitzer, & Bargh, 2013). Dual-process models have been used to demonstrate that behaviour is not only influenced by reflective factors (e.g. Ajzen, 1991; Bandura, 1978; Fishbein & Ajzen, 2010), but also by impulsive factors that may have a key role on health-related behaviours (see Evans, 2008 for a review). For instance, the reflective-impulsive model (Strack & Deutsch, 2004) suggests that people process information through two systems: the reflective system and the impulsive system. The reflective system allows people to make deliberative decisions whereas the impulsive system processes information automatically without cognitive effort from people. More details on dual-process models can be find on chapter 3.2 (section III). Although dual process models have been shown to be useful in explaining eating behaviours in adults, very few studies have been conducted with adolescents (Dohnke, Steinhilber, & Fuchs, 2015; Gerrits et al., 2010; Gerrits, de Ridder, de Wit, & Kuijer, 2009). Studies in younger samples have mainly assessed how social images (named prototypes) can implicitly influence eating behaviours. These studies have been helpful to show that impulsive measures related to social images can also influence eating behaviours, but no information was found about the role of more

general impulsive factors and its influence on behaviour when comparing to reflective factors. This limits the understanding of what factors better influence eating behaviours in young people.

According to the dual-process models, some boundary conditions (fatigue, alcohol, executive function, etc.) may influence the relationship between the impulsive and reflective systems and, in turn, influence health behaviours (Hofmann, Friese, & Strack, 2009). In fact, people are constantly confronted with palatable food and resisting it requires some individual skills. Inhibitory control is an important core skill when assessing executive function. Some evidence seems to demonstrate that lower control skills are associated with unhealthier eating behaviours and higher BMI in adults samples (Allan, Johnston, & Campbell, 2008, 2010; Nederkoorn, Braet, Van Eijs, Tanghe, & Jansen, 2006). In adolescence this inhibitory control skills are still being developed, and, so, adolescents tend to have lower skills when comparing with adults (Anderson, 2002). It would be crucial to have a better understanding on how inhibitory control influences the relationship between eating behaviours and the reflective, as well as, the impulsive system.

### *Factors influencing eating behaviours in childhood*

Systematic reviews investigating factors influencing eating behaviours amongst children and adolescents have found evidence that social factors (e.g., modelling and norms), individual factors (dietary intentions, knowledge, liking and preferences) and home environment have been associated with eating behaviours (McClain et al., 2009; Rasmussen et al., 2006; Van Der Horst et al., 2007).

McClain et al (2009) conducted a systematic review on the psychosocial factors influencing eating behaviours in young people (age range: 3-18 years old). Seventy seven cross-sectional and prospective papers were included in this review (the authors of the review did not present an overall sample size or enough data that

could allow to calculate it). Results revealed that the factors that more often positively influenced the intake of fruit, vegetables and/or juices were intentions to eat this type of food, knowledge, liking, preferences and modelling. For sugar snacking, attitudes and intentions were the only two consistent variables influencing positively this outcome. The authors also explored other eating behaviours categorised as “less healthy dietary intake” (no information was given about what food groups were included) that was mostly associated with intentions and modelling. These results give some insight on children’s eating behaviour, showing that several factors from social and individual levels differentially influence eating behaviours. However, this review excluded longitudinal studies and presented no information on the strength of the associations between the variables targeted and the behaviour, or data on the variance explained. According to the authors of this systematic review, only 2 studies were classified as having high methodological quality and two thirds were classed as having a strong quality. However, almost 30% of the studies included were only classified as “acceptable”, one study was classed as “weak”. Besides, when reporting the results, the authors of this systematic review did not analyse the data obtained separately by children and adolescents. These limitations restrict the full understanding of potentially specific key predictors of eating behaviours in each one of these developmental stages and highlight the need of interpreting the results with caution.

A less recent systematic review (Rasmussen et al., 2006) analysed 98 papers (mostly cross-sectional, again the authors of the review did not present information about the overall sample size) focused specifically on factors influencing FV intake in young people (age range 6-18 years old). The review found that sex, socio-economic position, preferences, parental intake, and home availability/accessibility were the main determinants of FV intake. That is, most of the studies included found that girls tend to eat more FV than boys; children/adolescents from a lower socio-economic

background tended to eat less FV; parents eating more FV influence positively the intake their child/adolescent; and, finally, those presenting favourable preferences and having more FV available at home tended more eat more FV. Despite the useful information collected and presented in this systematic review again the authors chose not to analyse the data on the correlates separately: for childhood and adolescence. Furthermore, most of the papers were cross-sectional (7% longitudinal) and 27% of the papers did not provide information about validity of the measures. No information about the strength of the associations between variables and behaviours was conveyed and there was also no data on the variance explained. This review did not evaluate the quality of the papers/studies included, and so, no critical appraisal was made helping the reader to better understand the limitations of these studies and of the conclusions made by the systematic review. These limitations together make the interpretation of the results found suggestive at best.

Interested in understanding the role of environmental correlates in eating behaviours, Van Der Horst et al. (2007) conducted a systematic review targeting studies conducted in young people aged 3 to 18 years old. Overall this systematic review included 56 studies and 29 studies (28 of them using a cross-sectional design) targeted children (2-12 years, once more, the authors of the review did not present enough information about the overall sample size). Results revealed no consistent associations between unhealthy snack/fast food intake and environment. In contrast, the intake of FV in childhood was positively associated with modelling, parental intake of FV and the availability/accessibility of FV at home. Similarly to the previous systematic reviews, Van Der Horst et al. (2007) did not report information on the strength of the associations between variables and behaviours and there was also no data presented on the variance explained. In addition, no information about the quality of the papers/studies included was reported.

The systematic reviews described above presented key problems that reflect the limitations of the research conducted so far. Some of the limitations can be observed on key issues such as: 1) study design: most of the studies included in these reviews were cross-sectional or prospective studies; 2) poor study methodology: lack of information on the validity of the measures used; 3) overemphasis on rational/reflective processes and limited use of impulsive/implicit processes; 5) focus on the relationships between factors and behavioural outcomes and little to no investigation on how the factors interrelate (e.g. how social or environmental factors contribute and influence individual factors). Considering the ecological perspective (Sallis et al., 2008) understanding these relationships would help to improve the design and ultimately the efficacy of intervention programmes.

Despite these limitations, results indicate that children's eating behaviours seem to be influenced by several factors, mostly associated with family environment and individual factors. As suggested by the ecological perspectives it is paramount to integrate these factors in order to identify the strongest relationships between these and eating behaviours. This could contribute to a better understanding of the complex factors surrounding eating behaviours.

### *Factors influencing eating behaviours in adolescence.*

Adolescence is a crucial point in human development. While eating is mostly under parents' control during childhood, the onus of control shifts as the child grows up. Adolescence is characterised by the beginning of autonomy (Erikson, 1968) where individuals start being relatively independent and self-governed (Wray-Lake, Crouter, & McHale, 2010). Probably because of these gains, studies seem to demonstrate that during adolescence, eating behaviours tend to decline in quality (Story, Neumark-Sztainer, & French, 2002). Some studies tried to understand the reasons behind this decline and found that when adolescents receive money (e.g. pocket money, first jobs, etc.), this money is often used to buy food, and the choices usually

fall on snacks and sweets (Darling, Reeder, McGee, & Williams, 2006; Farrell & Shields, 2007; Stok, De Ridder, Adriaanse, & De Wit, 2010).

The systematic review referred to above conducted by Van Der Horst et al. (2007), focused on environmental correlates of dietary behaviours. Of the 56 papers included, 27 papers targeted adolescents aged 13-18 years old (25 of them using a cross-sectional design). This review concluded that an authoritative parenting style, family connectedness and parental educational level were positively associated with FV intake. Further, these authors did not find consistent associations between unhealthy snack/fast food intake and environmental factors. Parental intake and parental modelling do not appear as an essential part of adolescents' snacks/fast food intake, has occurred during childhood. The authors identified only one study (cross sectional study, n= 208) investigating the school environment and no significant associations were found between school environment and snack/fast food intake.

Some key characteristics of this developmental stage might be responsible for the results reported in this systematic review. At this life stage, adolescents start spending more time at school and with friends, than with their family. This seems to be associated with a transition in adolescents' attributed relevance and perception of role models, moving from parents to peers (Sprinthall & Collins, 1994). In order to understand the effect of peers some studies have been conducted using a dual-process model – the Prototype Willingness Model (Gibbons & Gerrard, 1995). Gerrits et al. (2010) conducted a study aiming at understanding the role of prototypes on eating behaviours, i.e. a person of the same age who behaves in a specific way. For this study, researchers assessed 511 adolescents aged 14-19 years from 3 countries (Hungary, Netherlands and United States). Participants were asked to assess positively or negatively a healthy eater prototype and an unhealthy one, and then score how similar they felt to them. Results revealed that adolescents have positive

images of healthy eaters and negative images of unhealthy eaters, but only the identification of similarity with an unhealthy eater prototype predicted unhealthy eating practices. This seems to reveal the importance of others on eating behaviours, particularly on unhealthy eating behaviours. It is important to highlight that this study used a limited dietary assessment asking participants “how many servings of fruits and how many servings of vegetables they usually eat per day”. A similar question was used to assess “fatty foods” (9 high fat content foods, common to all countries in the study). No information about the validity of this measurement was provided.

Hewitt and Stephens (2008) analysed eating behaviours correlates in 261 adolescents aged 10-13 years using a cross sectional design. Participants were asked to answer a questionnaire based on the Theory of Planned Behaviour and to record how many days, in the past week, they ate foods from five different food groups: fruit, vegetables, treat foods, fizzy drinks and takeaways. Further, parents answered about their perception on their own responsibility for child-feeding and their parental influence on healthy eating through items assessing their perception and concerns regarding their child overweight/obesity, feeding practices and attitudes. Results revealed that subjective norms, attitudes and perceived behavioural control, explained 51% of the variance on intentions, and for dietary behaviour 44% of the variance was significantly explained by intention and perceived behavioural control. Parental influences on healthy eating were not associated with behaviour. Again, this study used a non-validated measure of dietary behaviour and only used one item per food groups to assess psychosocial factors which may contribute to some bias on the results found.

Neumark-Sztainer et al. (2003) in a cross sectional study with a sample of 3957 adolescents with an average age of 14.9 years (*SD* = 1.7) studied several predictors of FV intake, including food preferences, attitudes, social support, family meal patterns, food security, socio-economic status, and home availability of FV. The

results revealed that the strongest and direct predictor of FV intake was home availability, followed by preferences. The relationship between FV intake and social support for eating healthily, family meal patterns, food security, as well as, socio-economic status was mediated by home environment (food availability). Furthermore, the relationship between FV intake and attitudes, as well as, home availability of FV was mediated by preferences. This study showed some evidence of the complexity of FV intake.

Results of previous research highlight the importance of home environment, social and individual factors when studying adolescents' eating behaviours. Similarly to what happens in research conducted in this area with children, there is a clear lack of studies integrating these factors, limiting the conclusions on which factors have more influence on eating behaviours.

### *Factors influencing eating behaviours: from childhood to adolescence*

Research has been conducted on tracking eating behaviours over time, where tracking can be defined "as a tendency of individuals to maintain their rank or position in a group over time" (Malina, 1996). Despite the evidence that eating behaviours decline in quality during the transition from childhood to adolescence (Lytle, Seifert, Greenstein, & McGovern; Mannino, Lee, Mitchell, Smiciklas-Wright, & Birch, 2004), some studies found that intake of FV moderately tracks from childhood to adolescence (Resnicow et al., 1998; Wang, Bentley, Zhai, & Popkin, 2002). However the evidence in this area is lacking as only two studies were found in the literature that targeted tracking of FV intake from childhood into adolescence (Resnicow et al., 1998; Wang et al., 2002). No studies on tracking sweet/savoury food were found focusing on this period.

Nonetheless, there are some longitudinal studies focusing on the tracking of eating behaviours from adolescence to later in life. A longitudinal study in the United States followed 2376 adolescents,

every year, from the 7th to the 12th grade, to identify the food they would usually eat when they had the choice between 18 pairs of food – healthy vs. unhealthy (Kelder, Perry, Klepp, & Lytle, 1994). The results revealed that food choices tracked from early adolescence to later adolescence. Furthermore, a systematic review of longitudinal studies on eating behaviours found evidence that food intake tends to track from adolescence into adulthood (Craigie, Lake, Kelly, Adamson, & Mathers, 2011). More specifically, four studies (sample sizes range: 166-452) found a fair to moderate tracking correlations of FV intake. Only two studies (sample sizes range: 198-452) investigated tracking of foods containing sugar and/or fat and found poor to no tracking between the baseline and the follow-up in these food groups (Craigie et al., 2011), from adolescence adulthood. The fact that only two studies explored this relation restricts robust conclusions. More research is warranted in order to support these findings. Tracking on FV highlights the importance of improving healthy eating behaviours earlier in life.

Investigating which variables from childhood predict eating behaviours and their predictors during adolescence would support a greater understanding of eating behaviours in adolescence. It is clear from the systematic reviews cited above that there is a lack of high quality longitudinal studies on predictors of eating behaviours from childhood to adolescence (McClain et al., 2009; Pearson et al., 2009; Rasmussen et al., 2006; Sleddens et al., 2015; Van Der Horst et al., 2007). This highlights that research in this area is warranted.

### 1.1.2 The present study

The complexity of eating behaviours across the life span is evident, however, little is known about how specific constructs, assessed during childhood, influence eating behaviours in adolescence. Furthermore, most of the research attempting to understand eating behaviour predictors has focused on FV intake, and little is known

about what factors influence sweet/savoury vs. FV intake. It is important to attempt on what are the factors that influence choice.

Given the limitations observed in the studies presented so far, more and better research needs to be conducted in order to increase our understanding of the predictors, both reflective and impulsive, of FV and sweet/savoury food as well as on what are the key variables explaining eating behaviours from childhood to adolescence. Integrating variables from different established models by including individual, social and environmental factors, is likely to increase understanding on the complexity of eating behaviours and improve future interventions.

For the purpose of the present study, two different eating behaviours were investigated "*food intake*" and "*food choice*". The first was assessed using a food diary recoding 4 days (FAST) of food intake during childhood (Adamson et al., 2003) and through a 24h recall (INTAKE24) during adolescence (Foster, Hawkins, Delve, & Adamson, 2014). From this food intake assessment, two food groups were the focus of this thesis: sweet/savoury that can be eaten as snacks and FV (see appendix A for detailed list of foods included). Given this focus, specific terms will be used: "*unhealthy eating*" defined as the consumption of sweet/savoury food that can be eaten as snacks (e.g. sweets, chocolate, cake, crisps); and, "*healthy eating*" that refers to the consumption of fruit and vegetables. In the assessment of food intake in childhood, it was not possible to distinguish FV that can be eaten as a snack from all FV, for this reason, it was decided to also include all FV in the parental intake and food intake in adolescence. Food choice was assessed using a behavioural food choice task (Lappalainen & Epstein, 1990) during adolescence. Briefly, the adolescents could choose to obtain a healthy or unhealthy food after responding to each of 5 trials (see section III of this thesis focusing on adolescence). A reminder of these definitions can be found at the beginning of each section of the thesis).

This thesis used and collected data on eating behaviours and their predictors in a sub-sample of the Gateshead Millennium study (GMS; Parkinson, Pearce, et al., 2011), a British birth cohort study following 1029 children born in 1999/2000. The GMS aims to explore the growth and development of children with a focus on lifestyle behaviours, in particular nutrition, physical activity and sedentary behaviour. To date, the GMS collected information in 15 waves: 8 waves were took place during the first year of life of participating children (birth, 6 days, 10 days, 3 months, 6 weeks, 4, 8 and 12 months); then children were assessed at the age of 13 months; 13–21 months; 30 months; 5–6 years; 6–8 years; 8–10 years (Parkinson, Pearce, et al., 2011) and, most recently, 11-13 years.

For the purpose of this thesis, the transition from childhood to adolescence was explored. For this, data collected in 2006/2007, when the children were aged 6–8 years, was analysed (section II of this thesis). At this age, the main outcome was food intake (healthy and unhealthy eating). Using the ecological perspective, variables from the individual and social level were analysed. In terms of the individual level variables these included trying FV, liking FV, preferences between healthy and unhealthy food and BMI. The social level variables included parental food intake and deprivation level.

During adolescence, data on food intake, BMI and deprivation level collected in 2012 by the GMS team were included in the analysis of the adolescence section of this thesis (see section III for further details), and a specific sub-study on food choice and predictors of eating behaviours was conducted in the same year, i.e. when adolescents were 12-13 years old. In this sub-study, a dual-process model, using the reflective-impulsive model terminology (Strack & Deutsch, 2004), was investigated. Reflective predictors included were intention to eat (un)healthy food and perceived behavioural control (PBC) over eating (un)healthy food (both from the individual level). Impulsive predictors were tested assessing (un)healthy eater

prototypes (social level), temptation to eat (un)healthy food (individual level). Moreover, food availability at home (environmental level) and inhibitory control (individual level) were also assessed.

- ***General aims***

The current study analysed the role of individual, environmental and social correlates, during childhood and adolescence, in predicting eating behaviours. This work had three main aims, explored in each of the sections of the thesis:

**Aim 1:** To understand the relationships between predictors of food intake in childhood and their influence on healthy and unhealthy eating (section II);
**Aim 2:** To understand the relationships between predictors of eating behaviours (food choice and food intake) in adolescence and their influence on these behaviours (section III);
**Aim 3:** To understand how food intake and its predictors in childhood influence eating behaviours and their predictors in adolescence (section IV).

- ***Thesis overview***

The purpose of this chapter has been to introduce the rationale for this area of study and to outline the aims of this thesis.

This thesis has three main empirical sections that address the main aims described above.

**Section II** focuses on childhood. In this section, aim 1 was investigated by analysing relationships between individual and social predictors of food intake. Further, direct and indirect relationships between these predictors and food intake were identified.

**Section III** focuses on adolescence. This section addressed aim 2, and so, it investigated the relationships between individual, social and environmental predictors of eating behaviours (food intake and food choice) using a dual-process model. Additionally, direct and

indirect relationships between these predictors and food intake were identified.

**Section IV** brings together the findings from section II and III (aim 3). In this section, tracking of food intake from childhood to adolescence (healthy eating and unhealthy eating) was analysed. In this section, the relationships between food intake and its predictors at the age of 6-8 years with eating behaviours and their predictors at age 11-13 years was explored and reported.

**Section V** integrates all findings in a general discussion and conclusion. Strengths and limitations of the study are discussed. Implications for practice and future research are acknowledged.

# SECTION 2

# CHILDHOOD

*Glossary Reminder:*

**Eating behaviours:** Set of behaviours assessed across the thesis and described below:

**Food choice:** This variable was assessed during adolescence via an experimental behavioural food choice task. Adolescents could obtain 5 portions of healthy, unhealthy or a mix of both food (that can be eaten as snacks). The results presented reflect the number of healthy choices made (from 0-5) which are the reverse of the number of unhealthy ones made (pictures of the food included in this task can be found in appendix G).

**Food Intake:** was assessed via a 4 days food diary (FAST) during childhood and via a 24h recall (INTAKE24) during adolescence. Two specific behaviours were analysed across the thesis (detailed list of food included can be found in appendix A):

- **Unhealthy eating:** consumption of sweet/savoury food that can be eaten as snacks (e.g. sweets, chocolate, cake, crisps)
- **Healthy eating:** consumption of fruit and vegetables.

**Predictors:** this term is used in order to facilitate reading. However, it is important to highlight that the analysis in this thesis cannot imply any causality assumption. Only associations between the variables assessed can be established.

# Chapter 2.1 Factors influencing eating behaviours in childhood

### 2.1.1 Abstract

*Background:* The ecological perspective suggests that eating behaviours are influenced by individual, social and environmental factors that interact and influence behaviour. However, most studies have analysed these factors independently without exploring potential relationships. The present chapter aimed at describing and exploring how individual and social predictors of food intake are associated with each other and how these relate to child's food intake in a sample of children aged 6-8 years old.

*Methods:* 260 children completed a questionnaire measuring: trying fruits and vegetables (FV), liking FV, food preferences and knowledge about healthy eating. Information about level of deprivation and weight status were also analysed. Parents' food intake was assessed by a food frequency questionnaire (Bingham et al., 1997). The outcomes analysed in this chapter are child's healthy and unhealthy eating (food intake) assessed using the FAST food diary (Adamson et al., 2003). Relationships between the predictors and the outcomes were analysed using linear regressions and path analysis.

*Results:* In general children ate more often healthy than unhealthy food, liked fruits more than vegetables and demonstrated an average level of knowledge about healthy eating with mid-range scores. Healthier eating was directly associated with liking FV and least deprivation, whereas higher levels of unhealthy eating was associated with lower levels of liking more fruits and lower weight status. Some relationships were found between the predictors: 1) liking was also associated with trying the specific food and to stated preferences 2) Knowledge was associated with preferences.

*Conclusions:* Of the factors investigated, liking FV seems to have a stronger influence on child eating behaviours. These results suggest that children may benefit from interventions targeting liking FV by using techniques such as trying food. The variance explained

in both healthy and unhealthy eating was very low, further research in this area is needed and should attempt at circumventing some of the limitations discussed.

### 2.1.2 Introduction

Fruits and vegetables (FV) intake is highly recommended in order to prevent non-communicable diseases (Boeing et al., 2012; WHO, 2002). Nevertheless, intake of FV in young people remains lower in comparison with current guidelines (Bates et al., 2011; Health and Social Care Information Centre, 2015; Vereecken et al., 2004). Compelling evidence has shown that eating patterns in childhood tend to track into adulthood (Craigie et al., 2011; Mikkilä et al., 2005) and so, improving food intake in early life is essential to promote a long-term healthy eating pattern. For this to be achieved, it is important to better understand how the predictors of food intake in young people are related and how this, in turn, influence food intake itself.

Some theories have proposed that health behaviours are influenced by multilevel factors that are inter-related (Sallis et al., 2008).

Social factors are likely to influence children's behaviour since they are less autonomous than adolescents and adults. In fact, parents are role models and they highly influence their children (Araújo-Soares et al.,in press; Bandura, 1971). Reviews in the field have shown that parental intake is one of the most consistent predictors of children's intake (Pearson et al., 2009; Rasmussen et al., 2006). Parents do not only have a model role, they are also important in that they transmit their own knowledge about food to their children (Gibson, Wardle, & Watts, 1998). Gibson et al. (1998) found a strong correlation between mother's knowledge about healthy food and their child's knowledge. In contrast, they found that a child's intake of FV was not associated with the child's own knowledge. Findings from research in this area have not presented consistent associations between knowledge and dietary outcomes in children and

adolescents (Blanchette & Brug, 2005; McClain et al., 2009; Rasmussen et al., 2006). Parent's food intake can also have a strong influence on children's food preferences (Wardle & Cooke, 2008). It has been widely reported in the literature that food preferences have been consistently associated with food intake in children and adolescents (Blanchette & Brug, 2005; Rasmussen et al., 2006). For example, Domel et al. (1996) explored the influence of several psychosocial factors on FV intake and found that food preferences were the only significant predictor. More recently, De Bourdeaudhuij et al. (2008) investigated correlates of daily FV intake in nine European countries. They found that daily FV intake was more positively associated with liking and preference for many different FV. Some cautious is needed when interpreting past research in this area. In fact, previous research often misuses the concept of "preferences" as representing the same as liking (Mela, 2001). However, liking refers to the degree of pleasure or displeasure when eating a specific food, and so, an hedonic evaluation of food whereas preference refers to a choice between two or more food options (Mela, 2001).

Some evidence has shown a positive relationship between the number of foods tried and the total number of foods liked by the children (Russell & Worsley, 2007; Wardle et al., 2001). Indeed, repeated exposure to a specific food can modify liking of that food and this can be generalised to similar foods (Cooke, 2007). Repeated trying seems to be an important factor of liking and consequently of food intake.

Weight status is another individual factor that needs to be taken into account when studying eating behaviours. In their study, Hebestreit et al. (2014) found that energy intake is an important predictor of BMI in children aged 2-9 years old in eight European countries. Further, Nicklas et al. (2003) found that overweight in children was mostly associated with unhealthy eating patterns. Diet rich on sweet and savoury foods has been also associated with obesity in children

(Rennie et al., 2005). Thus, these studies suggest that overweight/obese children are likely to have particular patterns of eating established from previous eating experience.

Social factors such as level of deprivation and sex have also been found to influence food intake (Rasmussen et al., 2006). Some studies concluded that living in a deprived area not only has a negative impact on FV intake but it also seems positively associated with unhealthy (high sugar, high fat) food intake (Craig, McNeill, Macdiarmid, Masson, & Holmes, 2010; Rasmussen et al., 2006; van Sluijs et al., 2008). Other studies have found that girls tend to have a higher intake of FV than boys (Rasmussen et al., 2006; Vereecken et al., 2004). In the UK similar patterns have been reported boys tend to eat less FV in a daily basis and social inequalities on FV intake have been found (Caireen, 2014).

### 2.1.3 Aims

The present chapter will focus not only on individual level factors – such as knowledge, food preferences, liking FV, trying FV and weight status – but also on social factors level such as parental food intake, level of deprivation status and sex. The specific aims of the present chapter are to:

Aim 1: Describe all variables assessed;
Aim 2: Explore differences in all variables between boys and girls;
Aim 3: Explore differences in all variables between healthy weight and overweight/obese participants;
Aim 4: Explore differences in all variables between four multiple levels of deprivation;
Aim 5: Explore relationships between all predictors and food intake;
Aim 6: Explore the influence of the assessed predictors on child food intake.

### 2.1.4 Methods

#### *Participants and Procedures*

The present research analysed a sub-sample of the Gateshead Millennium study (GMS; Parkinson, Pearce, et al., 2011), a British birth cohort study following 1029 children born in 1999/2000. The GMS collected information on the first year of life, during childhood and adolescence in several waves (15 altogether). For the present chapter, data collected in 2006/2007, when the children were aged 6–8 years, were included (ethics reference Gateshead and South Tyneside Local Research Ethics Committee 06/Q0901/49). Two hundred and sixty parent-child pairs were assessed after providing an informed consent and assent, respectively.

The assessments at age 6-8 years were divided in 3 different visits: 1) first home visit: where the study was explained to the parents and consent forms were collected. At this stage, a 4 day food diary (Adamson et al., 2003) assessing child food intake was explained and given to the parents; 2) second home visit: the parent completed a food frequency questionnaire (Bingham et al., 1997) for their own intake and the child's food diary was collected; and finally, 3) school visit: where the child completed a questionnaire assessing knowledge about healthy eating, preferences liking and trying FV. Child's height and weight was measured at either visit one or two.

#### *Measures*

All measures can be found in appendix B.

*Child food intake* was assessed through the Food Assessment in Schools Tool (FAST) validated by Adamson et al. (2003). FAST is a combination of a food frequency and food diary in which all foods and drinks consumed over 4 days were recorded. For each day, a list of foods frequently eaten by children aged 6-8 years old (based on results for these age groups in the national diet and nutrition survey) was presented in each of 6 timeslots (Gregory & Lowe, 2000). Each

section also had a free text area where foods not appearing in the frequency lists could be recorded. Foods consumed by the child were recorded over 4 days – 2 weekend days and 2 school days. Parents recorded intake at home while trained lay observers recorded food intake at school. Only data from the mean daily frequency of healthy[2] (fruits and vegetables) and unhealthy (sugary, energy-dense, savoury) foods was used (using results from both parental record of child intake and observers record of school food intake). Higher scores in each of these variables mean higher intake of the food group.

*Sex* of the participants was recorded.

*Level of deprivation* was calculated from the postcodes of participants in the 15th wave of the GMS. The postcodes were converted to the Index of Multiple Deprivation (IMD) 2007 using the UK data service census support website (http://geoconvert.mimas.ac.uk/). IMD measures deprivation levels in England based on the geography Lower layer Super Output Area (LSOA) where the most deprived LSOA for each Index is given a rank of 1 and the least deprived LSOA is given a rank of 32,482 (Noble et al., 2007). For the purpose of the present chapter, the IMD ranks were divided in quartiles by dividing the British ranks into quarters and allocating each GMS participant in the respective quartile according to IMD rank. More deprived areas are represented in the lower quartiles and higher quartiles represent less deprived areas.

*Weight status:* Height was measured to 0.1 cm with a Leicester Portable height measure and weight measured to 0.1 kg with a TANITA TBF 300MA. Body mass index (BMI) was calculated and classified as obese, overweight or healthy weight according with the IOTF growth chart cut-offs – called BMI z-scores – which takes into

[2] A detailed list of food included in healthy food and unhealthy food can be found in appendix A

account the age, sex, height and weight of the participant (Cole, Bellizzi, Flegal, & Dietz, 2000).

*Parents' food intake* was evaluated via a food frequency questionnaire (Bingham et al., 1997). The questionnaire was designed to be self-administered where participants reported the average frequency of intake for each food over the past year. Nine response categories available ranged from "never or <1 per month" to "6 or more per day" from which a mean daily frequency of intake for each food can be calculated. For this study the mean daily frequency of selected foods was calculated for healthy and unhealthy foods[3]. Higher scores in each of these variables mean higher intake of each foods group.

The measures related to *knowledge*, *liking*, *trying* and *preferences*, were assessed using the questionnaire "thinking about food" (Schagen et al., 2005). This questionnaire was developed in 2003 by the National Foundation for Educational Research in collaboration with the University of Leeds to evaluate the impact of School Fruit and Vegetable Scheme. Briefly, this scheme offered a free piece of fruit or vegetable to children aged four to six years in more than 500 schools between 2000 and 2001. In 2004, this scheme was expanded to England to distribute around 440 million pieces of FV each year to over two million children in 18,000 schools (Schagen et al., 2005). Further details of each measure assessed here are presented below.

*Trying and liking FV* was assessed by showing the child 12 images of fruits and 12 images vegetables (Schagen et al., 2005), the child was asked to mark a cross if they had not tried and, if they had tried, the participants were asked to indicate whether they liked each of the foods shown, did not like them or if they were not sure whether they liked it or not (Figure 2.1-1). From these questions 4 variables were computed: 1) trying fruits; 2) liking fruits; 3) trying

[3] A detailed list of food included in healthy food and unhealthy food can be found in appendix A

vegetables, and 4) liking vegetables. The scores of these variables were calculated by addition of the number of fruits tried (for the trying variables) and liked (for the liking variables), leading to a scale ranging from 0 to 12, for each of the variables (liking and trying either vegetables or fruits). Therefore, higher scores indicate that the child tried (for the trying variables) or liked (for the liking variables) more fruits or vegetables.

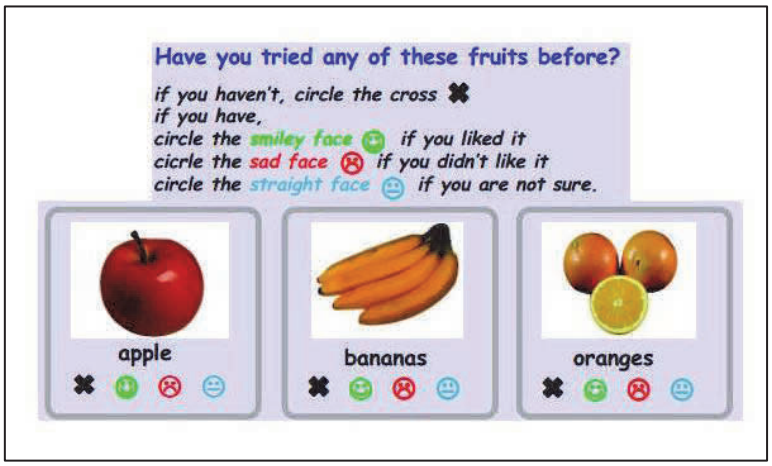


**Figure 2.1-1 - Example of the measures trying and liking fruits.**

*Food preferences* between healthy and unhealthy foods were evaluated by asking the child to choose their favourite food from a selection of five pairs (one healthy and one unhealthy food) – Figure 2.1-2 (Schagen et al., 2005).

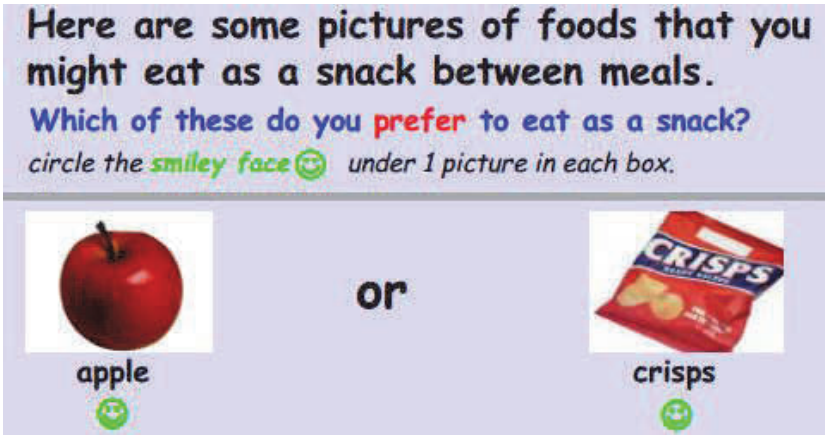


**Figure 2.1-2 - Example of the measure food preferences**

*Knowledge about healthy eating* was assessed through 3 different questions (Schagen et al., 2005):

1. *Choosing a healthy snack:* The child was asked to select the healthiest foods from a range of three foods combinations in 5 different items. The scale ranged from 0 to 5, where higher scores mean more knowledge about healthy foods.

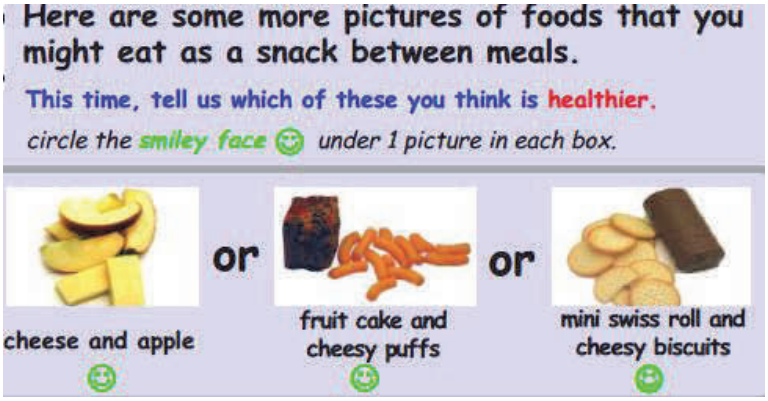


**Figure 2.1-3 - Example of the question choosing a healthy snack from the measure knowledge about healthy eating.**

2. *A balanced and healthy diet:* the child indicated how much of ten different foods/drinks should be eaten in order to have a balanced and healthy diet. The child had three answers options: 1) “a person should eat lots”, 2) “a person should eat some” and 3) “a person should eat small amount”. For each correct answer, one mark was given. Correct answers were counted, and so the scale for the variable ranged 0 to 10, where higher scores indicate greater knowledge about a balanced and healthy diet.

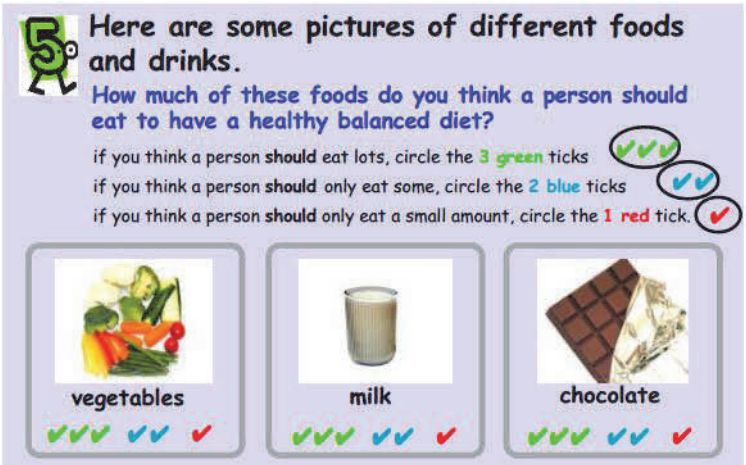


**Figure 2.1-4 - Example of the question: “balanced and healthy diet” from the measure knowledge about healthy eating.**

3. *Food that counts as a portion of fruit:* 9 pictures of food/drink items were shown to the participants. Participants were then asked to indicate whether the item 'did count', 'did not count' or if they were 'not sure' if the food counted as a portion of fruit. The final score ranged from 0 to 9, where higher scores indicate a greater knowledge about which foods counts as a portion of fruit.


**Figure 2.1-5 - Example of the question: "Food that counts as a portion of fruit" from the measure knowledge about healthy eating.**

General level of knowledge about healthy eating was calculated from the previous 3 questions, results ranging from 0 to 24 points, the maximum score indicating the highest level of knowledge about healthy eating.

### 2.1.5 Statistical Procedures

The distribution of the variables was investigated in order to test for normality. Most of the variables did not present a normal distribution, therefore non-parametric tests were used.

In order to explore the first aim (describe all variables), descriptive analyses were done. Aims two and three (exploring differences between boys/girls and healthy weight/at least overweight, respectively) were analysed by running Mann-Whitney tests, in order to explore differences between groups. The fourth aim was tested through Kruskal-Wallis tests where the differences between the four levels of deprivation were explored.

For aim 5 (explore relationship between all predictors and food intake) and aim 6 (explore the influence of the predictors on the child food intake), participants with missing data on any of the predictive measures were excluded. This decision was made given that previous research has demonstrated that missing data on predictor variables do not cause bias when they are not related to the outcome (Sterne et al., 2009), besides imputation can generate inconsistent data, distort relationships and may artificially reduce variance (Sterne et al., 2009). Then, a Spearman inter-correlation between all measures was conducted (aim 5). In order to analyse the influence of the predictors on the child's food intake (aim 6), 3 steps were performed: 1) independent simple linear regressions were conducted to identify significant predictors; 2) significant predictors were then included in an adjusted model using multiple linear regression; 3) to estimate indirect pathways (i.e. non-independent predictors of child's food intake, which are mediated through other predictors), the adjusted model was reconstructed as a path diagram. Measures that were not in the adjusted model (i.e. that were not independently predictive of child's food intake) were then added to the path diagram, and all paths or correlations with $p < .05$ were modelled. Statistical inference was based on bootstrapping procedure with n = 10,000 resample, which makes no assumptions about the sampling distribution. Model fit was assessed using model chi-square, comparative fit index (CFI), Goodness-of-Fit (GFI), root mean square error approximate (RMSEA). Adequate fit was defined as chi-square *p*-value over .05, CFI over .95, GFI over .95, RMSEA below .07 (Hooper, Coughlan, & Mullen, 2008). Standardised beta coefficients (β) were derived for each explanatory variable in order to allow comparing and estimating the relative importance of each measure (i.e. a standardised coefficient is the SD change in child's food intake elicited by a 1 SD change in the explanatory measure). Confidence intervals and the *p*-values of the tests will be reported in order to show the significance level. The results will be presented in tables

and figures, however, only statistically significant results will be reported in the text.

All standard statistical analyses were conducted using the Statistical Package for the Social Sciences 19 (SPSS) while path analyses were conducted in AMOS 17.0 (SPSS Inc, Chicago, IL).

### 2.1.6 Results

***Aim 1: Describe all variables assessed:***

The present study assessed 260 children (50.8% of girls) aged 6-8 years old (*Mean* = 7.33, *SD* = .45). Most of the participants came from areas of higher level of deprivation (64.9% in quartile 1 and 2). 76.4% of the participants were included in the group of healthy weight and 23.6% were at least overweight (5.8% of them were obese).

Descriptive results of all the measures assessed in the present chapter are shown in Table 2.1-1. Participants reported having tried most of the fruits and liked slightly more than half of them. Similar patterns were found regarding trying and liking vegetables. Children seem to be divided between the healthy and unhealthy foods preferences and demonstrated an average level of knowledge about healthy eating slightly above the mid-range score.

As regards to children's food intake, the results from the food diary have shown that children ate unhealthy foods on average .83 times a day and healthy foods 1.35 times. Parents also reported eating more healthy food comparing with unhealthy food. Parents were found to have reported very high intakes of FV a problem previously reported for this FFQ therefore the results of the parents' food intake will be interpreted as ranks instead of a continuous variable. This limitation will be discussed in the discussion section of the present chapter.

**Table 2.1-1 - Descriptive statistics of all the variables assessed (n=260)**

| | Mean | *Standard Deviation* | Median | *IQR* *25* | *75* |
|---|---|---|---|---|---|
| Child H eating | 1.35 | .80 | 1.25 | .88 | 1.75 |
| Child UH eating | .83 | .34 | .83 | .58 | 1.08 |
| BMI z score | .34 | 1.08 | .32 | -.42 | 1.11 |
| IMD | 12883.20 | 8713.64 | 10182.00 | 5544.00 | 19483.00 |
| Parent's H eating | 7.99 | 5.01 | 7.17 | 5.26 | 10.07 |
| Parent's UH eating | 2.24 | 1.99 | 1.82 | .82 | 3.18 |
| Knowledge | 14.53 | 2.62 | 15.00 | 13.00 | 16.00 |
| Trying (fruits) | 10.58 | 2.04 | 11.00 | 10.00 | 12.00 |
| Liking (fruits) | 7.43 | 2.87 | 8.00 | 5.00 | 9.75 |
| Trying (vegetables) | 10.05 | 2.79 | 12.00 | 9.00 | 12.00 |
| Liking (vegetables) | 6.00 | 3.12 | 6.00 | 4.00 | 8.00 |
| Preferences (H) | 2.78 | 1.42 | 3.00 | 2.00 | 4.00 |

*Notes: H = healthy foods; UH = unhealthy foods; BMI = Body Mass Index; IMD = Index of Multiple Deprivation; IQR = Interquartile range*

### *Aim 2: Exploring differences in all variables between boys and girls:*

All the results of the Mann-Whitney analyses to compare boys and girls can be found in the Table 2.1-2. The only statistically significant result revealed that parents of boys reported eating more unhealthy food than parents of girls ($p$=.008).

**Table 2.1-2 – Descriptive and Mann-Whitney tests results by Sex.**

| | Sex | | |
|---|---|---|---|
| | Boys (*n*=128) | Girls (*n*=132) | |
| | *Median* | *Median* | *P* |
| | *(M; SD)* | *(M; SD)* | |
| IMD rank | 12675.00 (13658.22; 8851.50) | 9369.00 (11707.28; 8205.92) | .087 |
| BMI z-score | .27 (.37; 1.14) | .32 (.38; 1.03) | .748 |
| Trying Fruits | 11.50 (10.46; 2.23) | 11.00 (10.69; 1.84) | .734 |
| Liking Fruits | 8.00 (7.49; 3.12) | 8.00 (7.38; 2.61) | .516 |
| Trying Vegetables | 11.00 (9.58; 3.29) | 12.00 (10.51; 2.12) | .074 |
| Liking Vegetables | 6.00 (5.98; 3.38 | 6.00 (6.02; 2.87) | .822 |
| Food preferences H | 3.00 (2.85; 1.48) | 3.00 (2.72; 1.37) | .409 |
| Knowledge | 15.00 (14.59; 2.89) | 15.00 (14.48; 2.34) | .660 |
| Child's H eating | 1.13 (1.33; .86) | 1.31 (1.37; 1.75) | .430 |
| Child's UH eating | .83 (.84; .33) | .83 (.82; .36) | .432 |
| Parent's H eating | 7.17 (7.99; 4.78) | 7.21 (7.99; 5.26) | .761 |
| Parent's UH eating | 2.22 (2.57; 2.21) | 1.61 (1.92; 1.70) | **.008** |

*Note: H = healthy foods; UH = unhealthy foods; BMI = Body Mass Index; IMD = Index of Multiple Deprivation.*

### *Aim 3: Exploring differences in all variables between healthy weight and overweight/obese participants:*

Results of the Mann-Whitney analyses can be found in the Table 2.1-3. The healthy weight group lived in least deprived areas compared with the group of people who are at least overweight (*p*=.006). The healthy weight group reported trying more fruits (*p*=.015) and liking more vegetables (*p*=.018) than the overweight/obese group.

**Table 2.1-3 – Descriptive and Mann-Whitney tests results by Weight Status.**

| | Weight Status | | |
|---|---|---|---|
| | HW (*n*=198) | OWOB (*n*=61) | |
| | *Median* | *Median* | *p* |
| | *(M; SD)* | *(M; SD)* | |
| IMD rank | 12675.00 (13568.52; 8743.12) | 7734.00 (9842.44; 7331.20) | **.006** |
| BMI z-score | .07 (-.07; .77) | 1.72 (1.81; .60) | **.000** |
| Trying Fruits | 12.00 (10.70; 2.02) | 11.00 (10.15; 2.07) | **.015** |
| Liking Fruits | 8.00 (7.57; 2.87) | 7.00 (7.00; 2.88) | .129 |
| Trying Vegetables | 12.00 (10.23; 2.67) | 11.00 (9.44; 3.13) | .063 |
| Liking Vegetables | 6.00 (6.27; 3.09) | 5.00 (5.20; 3.10) | **.018** |
| Food preferences H | 3.00 (2.76; 1.46) | 3.00 (2.85; 1.31) | .730 |
| Knowledge | 15.00 (14.54; 2.70) | 14.00 (14.52; 2.42) | .819 |
| Child's H eating | 1.25 (1.37; .81) | 1.19 (1.28; .78) | .404 |
| Child's UH eating | .83 (.85; .34) | .75 (.79; .36) | .237 |
| Parent's H eating | 7.17 (7.85; 4.62) | 7.31 (8.24; 5.96) | .894 |
| Parent's UH eating | 1.66 (2.14; 1.84) | 2.06 (2.56; 2.40) | .199 |

*Note: H = healthy foods; UH = unhealthy foods; HW = healthy weight; OWOB = overweight or obese; BMI = Body Mass Index; IMD = Index of Multiple Deprivation.*

### *Aim 4: Exploring differences in all variables between four multiple levels of deprivation:*

All results of the Kruskal-Wallis tests are presented in the

Table 2.1-4. The IMD groups differed on the healthy eating in children (*p*=.003). The pairwise comparison with adjusted *p*-values showed the most deprived group (1st quartile) reported eating significantly less healthy food than the 3rd quartile (*p* = .003). Furthermore, there were also differences between the levels of deprivation on parents' healthy eating (*p* < .001). The pairwise comparison with adjusted *p*-values showed that the most deprived group (1st quartile) reported eating significantly less healthy food than the 3rd (*p* < .001) and the least deprived group (4th quartile) (*p* = .007).

### *Aim 5: Exploring the relationship between all predictors and food intake:*

Although most correlations between the variables are low (between -.3 to .3) – Table 2.1-5 –, some moderate to high correlations were found indicating that:

- Eating more healthy food was associated with liking more fruits (r = .34; p < .001), trying more vegetables (r = .34; p < .001) and liking more vegetables (r = .42; p < .001).
- Trying more fruits was associated with liking more fruits (r = .46; p < .001) as well as trying (r = .63; p < .001) and liking more vegetables (r = .34; p < .001).
- Liking more fruits was associated with trying (r = .41; p < .001) and liking more vegetables (r = .58; p < .001), as well as to higher levels of healthy foods preferences (r = .35; p < .001).
- Trying more vegetables was associated with liking more vegetables (r = .54; p < .001).

**Table 2.1-4 - Descriptive and Kruskal-Wallis results by the level of deprivation groups.**

| | IMD | | | | |
|---|---|---|---|---|---|
| | 1st (*n*=99) *Mean Rank (M; SD)* | 2nd (*n*=64) *Mean Rank (M; SD)* | 3rd (*n*=52) *Mean Rank (M; SD)* | 4th (*n*=36) *Mean Rank (M; SD)* | *P* |
| IMD rank | 50.00 (4373.71; | 131.50 (11450.33; | 189.50 (19976.87; | 233.50 (26997.97; | **.000** |
| BMI z-score | 136.53 (.53; 1.17) | 143.54 (.61; 1.06) | 105.64 (.09; .92) | 92.10 (-.12; .94) | **.000** |
| Trying Fruits | 126.57 (10.60; 2.04) | 127.20 (10.56; 2.20) | 126.66 (10.77; 1.60) | 121.33 (10.28; 2.30) | .977 |
| Liking Fruits | 121.14 (7.21; 2.73) | 139.08 (7.89; 2.85) | 130.12 (7.50; 3.14) | 110.17 (6.72; 2.83) | .217 |
| Trying Vegetables | 124.73 (9.95; 2.91) | 128.33 (10.05; 2.91) | 133.38 (10.48; 2.38) | 114.71 (9.81; 2.66) | .627 |
| Liking Vegetables | 125.88 (5.89; 3.05) | 123.76 (5.86; 3.29) | 138.65 (6.52; 3.07) | 112.03 (5.42; 2.94) | .391 |
| Food preferences (H) | 127.35 (2.80; 1.47) | 140.48 (3.03; 1.43) | 121.08 (2.67; 1.34) | 103.65 (2.39; 1.27) | .088 |
| Knowledge | 117.74 (14.33; 2.26) | 126.14 (14.50; 3.04) | 131.69 (14.85; 2.49) | 140.24 (15.03; 2.59) | .387 |
| Child's eating (H) | 90.80a (1.12; .66) | 108.32 (1.31; .62) | 130.15a (1.68; .92) | 120.56 (1.57; 1.02) | **.003** |
| Child's eating (UH) | 103.87 (.82; .35) | 95.89 (.79; .39) | 119.88 (.88; .31) | 120.06 (.89; .31) | .154 |
| Parent's eating (H) | 100.55ab (6.67; 5.28) | 130.56 (8.14; 4.14) | 152.58a (9.68; 5.20) | 146.15b (9.18; 4.95) | **.000** |
| Parent's eating (UH) | 123.09 (2.37; 2.40) | 134.35 (2.44; 1.88) | 114.96 (1.87; 1.43) | 131.86 (2.26; 1.68) | .487 |

*Note: H= healthy foods; UH= unhealthy foods; BMI: Body Mass Index; IMD = Index of Multiple Deprivation; 1st quartile = most deprived and 4th quartile = least deprived. For each variable, group values with the same lowercase letters significantly differ from one another.*

**Table 2.1-5- Inter-correlations between the variables assessed (n=220)**

| | CH | CUH | BMIz | IMD | PH | PUH | K | TF | LF | TV | LV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Child H eating (CH) | | | | | | | | | | | |
| Child UH eating (CUH) | -.03 | | | | | | | | | | |
| BMI z score (BMIz) | -.05 | -.16* | | | | | | | | | |
| IMD | .21** | .12 | -.21** | | | | | | | | |
| Parent's H eating (PH) | .23** | -.10 | -.01 | .28*** | | | | | | | |
| Parent's UH eating (PUH) | -.07 | .17* | .03 | .01 | .10 | | | | | | |
| Knowledge (K) | .05 | -.11 | .08 | .14* | -.01 | -.07 | | | | | |
| Trying (fruits) (TF) | .27*** | -.08 | -.18** | -.02 | .04 | -.16* | .02 | | | | |
| Liking (fruits) (LF) | .34*** | -.17* | -.05 | .09 | .12 | -.02 | .06 | .46*** | | | |
| Trying (veg.) (TV) | .34*** | -.13 | -.15* | -.02 | .15* | -.08 | .02 | .63*** | .41*** | | |
| Liking (veg.) (LV) | .42*** | -.11 | -.10 | .01 | .19** | -.08 | .02 | .34*** | .58*** | .54*** | |
| Preferences (H) (PH) | .10 | -.17* | .06 | -.11 | -.01 | -.02 | .19** | .19** | .35*** | .14* | .24*** |

*Notes: N=220. H = healthy foods; UH = unhealthy foods; BMI: Body Mass Index; IMD: Index of Multiple Deprivation. *p<.05; **p<.01; ***p<.001*

### *Aim 6: Exploring the influence of the predictors on child food intake.*

The influence of the predictors assessed on child food intake was explored through 3 steps: 1) independent linear regressions; 2) adjusted multiple regression and 3) path analyses.

#### *Step 1 – Independent linear regression predicting child's healthy eating*

Six of the 10 variables assessed in the present chapter predicted significantly child's healthy eating: level of deprivation (β= .24, 95% CI [.00, .00]), trying fruits (β= .30, 95% CI [.07, .16]), liking fruits (β= .34, 95% CI [.06, .13]), trying vegetables (β= .36, 95% CI [.08, .13]), liking vegetables (β= .42, 95% CI [.07, .15]) and parent's healthy eating (β= .18, 95% CI [.01, .05]).

#### *Step 2 – Adjusted multivariate regression predicting child's healthy eating*

The significant independent predictors found in the step 1 were included in an adjusted model all together. The results of the multivariate regression showed that only level of deprivation (β= .23, 95% CI [.07, .26]) and liking vegetables (β= .31, 95% CI [.04, .13]) remained significant. Therefore, living in a least deprived area and liking more vegetables was associated with healthier eating.

#### *Step 3 – Path analyses predicting child's healthy eating*

The two significant predictors found in the step 2 were the starting point to draw the path analysis. The final model (Figure 2.1-6) from the path analysis was drawn by adding the variables gradually (see appendix C with all the steps). Three significant direct predictors were found in the final model (listed from the highest total effect to the lowest): 1) liking vegetables (β= .35, 95% CI [.21, .48]); 2) deprivation level (β= .24, 95% CI [.12, .34]), and finally, 3) liking fruits

(β= .16, 95% CI [.02, .30]). Although none of preferences, trying fruits and trying vegetables were directly predictive of the child's healthy eating, each influenced at least one direct predictor. That is, healthy eating was influenced indirectly by preferences (β= .15, 95% CI [.08, .23]), trying fruits (β= .08, 95% CI [.01, .15]) and trying vegetables (β= .20, 95% CI [.11, .28]). Furthermore, knowledge was mediated through preference (β= .03, 95% CI [.01, .06]). Finally, trying vegetables covaried with trying fruits ($p$<.001) and liking vegetables with liking fruits ($p$<.001), i.e. a correlation between variables was found.

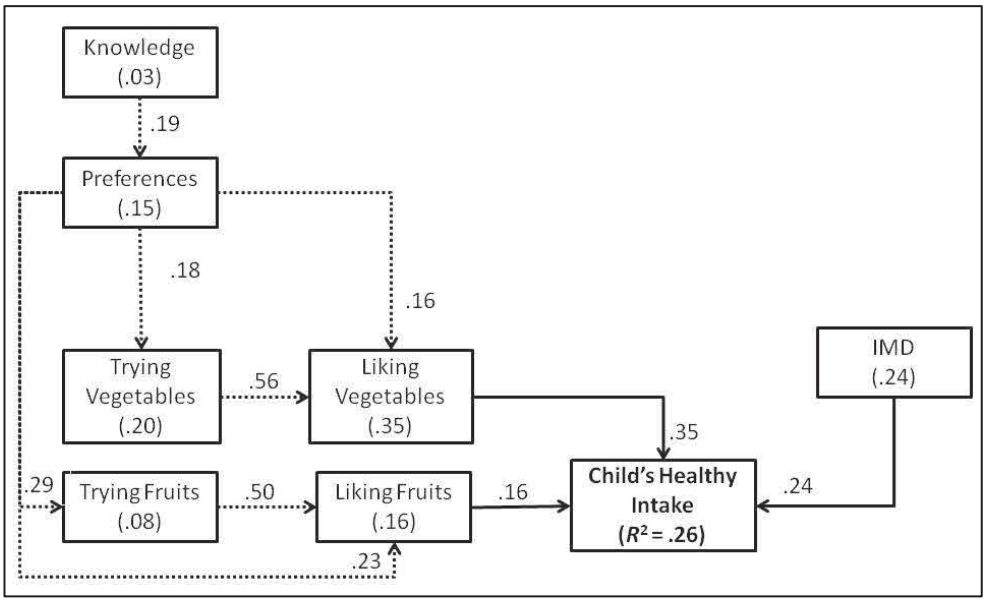


**Figure 2.1-6 - Path diagram showing direct and indirect predictors of the child's healthy eating.**

*Note:The final model only presents significant effects (p<.05) which are represented by arrows. The arrow direction indicates the hypothesised direction of the causal flow and standardized coefficients (β) are presented above each arrow. The dashed arrows represent indirect effects, i.e. pathways mediated through at least one intermediate predictor (e.g. Preferences -> Liking vegetables -> Child's healthy eating). In contrast, the solid arrows show the direct effects which are going straight from the independent variable to the child's healthy eating. The standardised total effect for each variable is the sum of the direct and indirect effects and are shown under the variable name. Error terms and co-variances are omitted for simplicity. In this specific model trying vegetables covaried with trying fruits (p<.001) and liking vegetables with liking fruits (p<.001). Model fit: $\chi^2(16)$ = 17.83, p = .33, RMSEA = .02 [90%CI = .00, .07], GFI = .98, CFI = 1.00. N = 214.*

### *Step 1 – Independent linear regression predicting child's unhealthy eating*

Five of the 10 variables assessed in the present chapter predicted independently and significantly the child's unhealthy eating: BMI z-score (β= -.14, 95% CI [-.09, -.01]), liking fruits (β= -.17, 95% CI [-.04, -.01]), preferences (β= -.14, 95% CI [-.06, -.00]), knowledge (β= -.13, 95% CI [-.03, -.00]) and parent's unhealthy eating (β= .12, 95% CI [.00, .04]).

### *Step 2 – Adjusted multivariate regression predicting child's unhealthy eating*

The five measures were then included in an adjusted model. The results demonstrated that BMI z-score (β= -.15, 95% CI [-.09, -.01]), liking fruits (β= -.16, 95% CI [-.04, -.00]) and parents' unhealthy eating (β= .12, 95% CI [.00, .04]) remained significant. Therefore, children with lower BMI, liking less fruits and having parents who reported eating more unhealthy food tended to eat more unhealthy food.

### *Step 3 – Path analyses predicting child's unhealthy eating*

The significant predictors found in the step 2 were then included gradually in the path analyses (see appendix D with all the steps). In the final model – Figure 2.1-7 – two direct predictors presented similar total effects, with liking fruits being slightly higher (β= -.18, 95% CI [-.30, -.05]) than BMI z-score (β= -.15, 95% CI [-.27, -.03]). Although the other variables did not independently predict the child's unhealthy eating, preferences influenced indirectly unhealthy eating (β= -.07, 95% CI [-.13, -.02]), the same happened with trying fruits (β= -.09, 95% CI [-.13, -.02]) and IMD (β= .04, 95% CI [.01, .09]). Furthermore, knowledge was mediated by preferences (β= -.01, 95% CI [-.03, -.00]). Finally, trying vegetables covaried with trying fruits

($p$<.001) and liking vegetables with liking fruits ($p$<.001), i.e. a correlation was found between the variables.

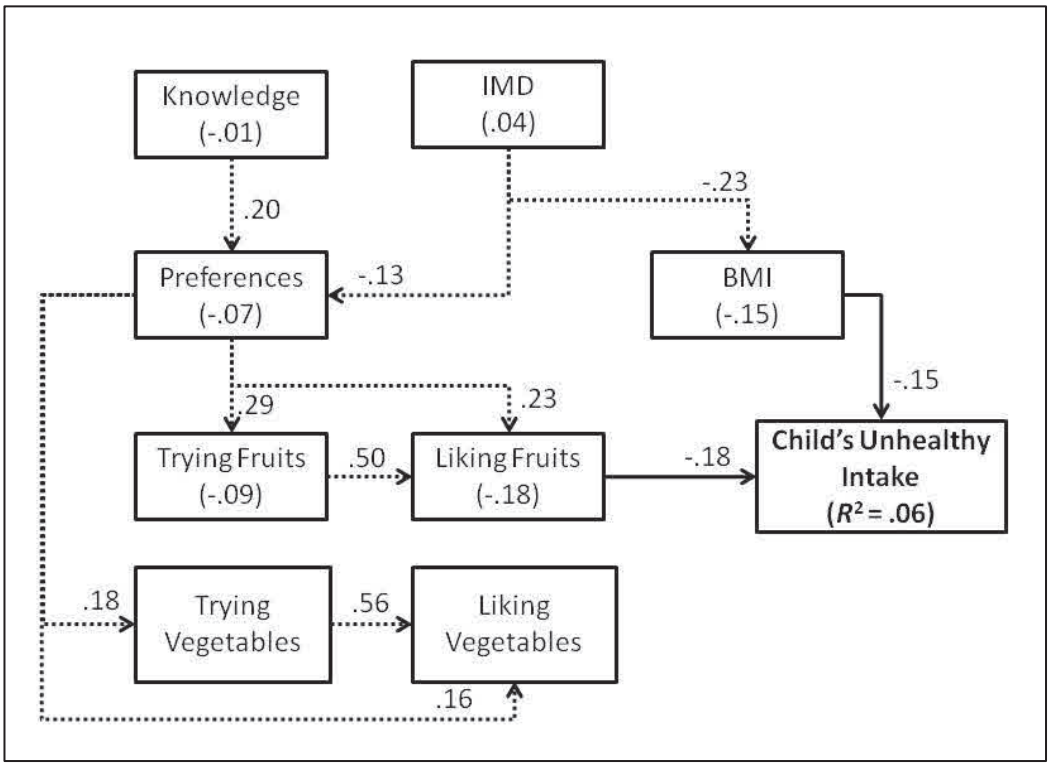


**Figure 2.1-7 - Path diagram showing direct and indirect predictors of the child's unhealthy eating.**

*Note: The final model only presents significant effects (p<.05) which are represented by arrows. The arrow direction indicates the hypothesised direction of the causal flow and the standardized coefficients (β) are presented above each arrow. The dashed arrows represent the indirect effects, i.e. the pathways mediated through at least one intermediate predictor (e.g. Preferences -> Liking fruits -> Child's unhealthy eating). In contrast, the solid arrows show the direct effects which are going straight from the independent variable to the child's unhealthy eating. The standardised total effect for each variable is the sum of the direct and indirect effects and are shown under the variable name. Error terms and co-variances are omitted for simplicity. In this specific model trying vegetables covariate with trying fruits (p<.001) and liking vegetables with liking fruits (p<.001). Model fit: $\chi^2(23) = 29.39$, $p = .17$, RMSEA = .04 [90%CI = .00, .07], GFI = .97, CFI = .99. N = 214.*

### 2.1.7 Discussion

This chapter aimed to explore predictors of food intake in childhood. The descriptive results revealed that children have more often eaten healthy than unhealthy food, and a similar result was found for parents. Furthermore, children tend to like fruits more than vegetables and presented mid-range score in knowledge about

healthy eating. Preferences were quite equal between healthy and unhealthy foods.

Regarding the relationships between the assessed variables and the outcomes, liking food was the variable that stood out. Indeed, the strongest predictor of healthy eating was liking vegetables and, for unhealthy food, it was liking fruits. As suggested by Mela (2001), preferences and liking seem to be two distinct factors. Indeed, as showed in the model predicting unhealthy eating, preferences have a very low total effect on the outcome comparing with liking fruits. A similar pattern was observed in the model predicting healthy eating with a large difference between the total effects from preferences and liking vegetables. This shows the importance of using clear definitions of liking and preferences in future research to facilitate comparison of results of different studies. At the age of 6-8 years old, children already present preferences to a certain type of food (Birch, 1999). Here, results have shown that preferences did not predict directly the child intake, but was mediated through trying and liking FV. Not surprisingly, the more the child likes vegetables and fruits the more they have consumed healthy foods (which were also FV, in the present study). Similarly to previous research, liking was the most important factor associated with intake (Blanchette & Brug, 2005). Unhealthy eating was not directly associated with liking vegetables as was found in the healthy food model which might be due to the fact that unhealthy food has more similar characteristics with fruits than vegetables. That is, fruits are sweeter and have higher levels of sugar and are more often eaten as a snack compared with vegetables. Furthermore, children seem to like vegetables less than fruits. This might be related to the fact that children are predisposed biologically to like sugary and energy-dense foods (Birch, 1999; Russell & Worsley, 2007). Children with higher scores on liking fruits tended to eat less unhealthy food. These results showing the importance of ‘liking’ are promising and suggest that future interventions aiming at promoting healthy eating should include strategies to improve liking of fruits since it seems to be a potential

key predictor not only for increased healthy eating but also decreased unhealthy eating.

The present results revealed that trying the food is strongly associated with liking it. Therefore, one possible way to improve liking of FV is to give children the opportunity to try several FV. Previous research has found that repeated exposure of a child to vegetables improves the chance (s)he starts liking it. For instance, Wardle et al. (2003) in a sample of children aged 5-8 years old found that exposure to red pepper every day for 10 days significantly improved liking and the intake of this vegetable, compared to a control group and a reward group (where children could obtain stickers featuring a variety of well-known cartoon characters every time children ate a vegetable). Another intervention study aiming at improving the liking and intake of vegetables compared three experimental groups: exposure, information and control (Wardle, Cooke, et al., 2003). It was found that the exposure group reported significantly higher scores on liking vegetables compared to the other groups at the end of the intervention. Further, the information group did not differ from the control group. This shows that having knowledge about what is healthy may not have an influence on intake. Indeed, the results of the present chapter showed that knowledge was not directly associated with food intake. Information campaigns about healthy eating are unlikely to be enough to influence behaviour.

Level of deprivation was also directly associated with healthy eating, showing that less deprived children have more often eaten healthy food comparing with children living in more deprived areas. These findings support the work of others that has shown that social inequalities affect healthy eating (Craig et al., 2010; Rasmussen et al., 2006; Turrell & Vandevijvere, 2015; van Sluijs et al., 2008). In the present chapter, the deprivation groups differed on child and parents healthy eating, where people living in least deprived areas reported eating more healthy food. Further, children living in least deprived

areas presented lower levels of BMI. These results might indicate that children from least deprived areas may have more healthy food access/availability. Interestingly, no differences by level of deprivation were found for preferences, liking, trying or knowledge. These results raise several questions about the way of improving future interventions by taking into account socio-economic status. Currently, there is limited evidence on how to decrease social inequalities in eating behaviours. As argued by Turell and Vandevijvere (2015), planning interventions targeting social inequalities is challenging due to the large number of factors which interact and differ at various levels (individual, environmental, social, etc) and across the life span. In fact, the current chapter shows that deprivation level is not the only factor predicting child intake, and some other important factors need to be taken into account. Future interventions should nevertheless aim at not increasing health inequalities and if possible decrease these by focusing on interventions that make FV available allowing children to try them, particularly in settings where children spend a lot of their time, for example at the school setting.

The negative association found between BMI and unhealthy eating seems against results obtained in previous research (Hebestreit et al., 2014; Nicklas et al., 2003). A possible explanation would be that parents might have identified their child weight status and therefore limited their intake of unhealthy food. However, a study conducted by Jones et al. (2012) in the same population found that most of the parents of children at the same age of the current sample were unable to identify that their child was overweight or “very overweight”. Other explanations could be that these children are able to identify themselves as overweight/obese and control their own intake. In the methodology used, researchers did not intentionally give the weight information to participants, but the child could see the value in the scale. Additionally, it might also indicate that those with higher BMI do not necessarily eat more unhealthy food more frequently than their healthy weight peers, but may eat larger portion sizes. Also, the

unhealthy foods investigated were a limited range of foods and so does not include all aspects of intake. Children with higher BMI may have unhealthier patterns of eating during main meals, or when eating other type of foods, but this was not controlled for on this study. These hypotheses need to be explored in future studies.

In the present chapter, parent's healthy and unhealthy eating was not significantly associated with the child's food intake. These results are in contrast with previous research which has found this predictor to be consistently associated with children's food intake (Pearson et al., 2009; Rasmussen et al., 2006). However, some caution is needed when interpreting the results found, some limitations need to be considered and are discussed in the limitations section below.

The variance explained in both models was low to moderate (6% and 26% for unhealthy and healthy eating, respectively), which indicates that other predictors need to be considered when predicting eating behaviours in children. For example, when conducting the analysis presented here there was no available data on predictors of unhealthy food, such as trying and liking these types of food (excepting for preferences). Studying such complex behaviours is challenging since many predictors interact in everyday life. Some reviews have pointed to other predictors, such as self-efficacy, outcome expectations, intentions, attitudes etc. (e.g. Blanchette & Brug, 2005; McClain et al., 2009). Further research with larger samples is warranted in order to support the findings. Additionally, research in this area should test other predictors in complex models in order to explore which of them presents higher weight on eating behaviours.

- ***Strenghts and Limitations***

Some limitations of the study presented in this chapter should be noted. All dietary assessments have some disadvantages and there is no consensus of which method most accurately reflects usual intake (McPherson, Hoelscher, Alexander, Scanlon, & Serdula, 2000;

Thompson & Subar, 2013). Thompson and Subar (2013) suggest that recording food intake may increase people's awareness of intake, which, consequently, may influence the intake itself. However, a systematic review of meta-analyses found no evidence of the influence of measurements in a single session on changing behaviour (Rodrigues, O'Brien, French, Glidewell, & Sniehotta, 2015). Further, food intake was measured by parents and observers, and so, even if parents would change their child's behaviour by reporting their intake, observers were trained as external examiners of children's intake, also contributing to limit the effect reported by Thompson and Subar (2013).

By using the food frequency questionnaire (FFQ) to assess parents' food intake, parents seem to have over reported their own FV intake as previously found by Michels et al. (2005). To overcome this problem, parents' intake needs to be interpreted carefully. In the present study parents' food intake was interpreted as ranks (e.g. person A who reported eating 5 FV is in a higher relative position than the person B that reported eating 2 FV) instead of a continuous variable (e.g. person A eats exactly 5 FV). The potential for error with using a significance level of 0.05 is also a limitation, since there is a 5% chance of error in finding a significant result, that is finding a significant relationship when no such relationship exist (type I error). However, the existence of these errors can often be spotted due to lack of meaning of the findings. All of the significant results found in the current chapter were explainable.

Furthermore, by using a cross-sectional design the evidence for real relationships is suggestive at best. However, it is still interesting to find that significant and explainable associations were present. Further research replicating the model hypothesised in the present chapter would help to confirm and gain a consensus on results.

Despite these limitations, the study provides useful findings. Individual factors were the strongest factors associated with food intake. This highlights the need of integrating children directly in

health promotion programs and not only parents/carers. Further, investigating such a complex model provided useful information for future research and interventions which should consider including not only individual but also environmental and social strategies to improve eating behaviours.

# SECTION 3

# ADOLESCENCE

*Glossary Reminder:*

**Eating behaviours:** Set of behaviours assessed across the thesis and described below:

**Food choice:** This variable was assessed during adolescence via an experimental behavioural food choice task. Adolescents could obtain 5 portions of healthy, unhealthy or a mix of both food (that can be eaten as snacks). The results presented reflect the number of healthy choices made (from 0-5) which are the reverse of the number of unhealthy ones made (pictures of the food included in this task can be found in appendix G).

**Food Intake:** was assessed via a 4 days food diary (FAST) during childhood and via a 24h recall (INTAKE24) during adolescence. Two specific behaviours were analysed across the thesis (detailed list of food included can be found in appendix A):

- **Unhealthy eating:** consumption of sweet/savoury food that can be eaten as snacks (e.g. sweets, chocolate, cake, crisps)
- **Healthy eating:** consumption of fruit and vegetables.

**Predictors:** this term is used in order to facilitate reading. However, it is important to highlight that the analysis in this thesis cannot imply any causality assumption. Only associations between the variables assessed can be established.

# Chapter 3.1 Describing predictors of food choice and food intake in adolescence.

### 3.1.1 Abstract

*Background:* Evidence has shown that adolescents' eating behaviours are influenced by multiple factors. The aim of this chapter is to describe potential predictors of food choice and food intake in adolescents as well as analyse the relationship between the measures and the differences by sex, level of deprivation and weight status.

*Method:* A total of 303 adolescents out of 525 GMS participants at the age of 12-13 years completed a questionnaire with items assessing reflective (perceived behavioural control (PBC) and intentions) and impulsive measures (temptation and eater prototypes) related to healthy and unhealthy food. Home availability of both types of food was also assessed. In addition, computer based tasks were used to assess executive function: attentional bias towards healthy and unhealthy food and inhibitory control. A food choice task was also implemented allowing individuals to select between healthy and unhealthy foods. Food intake was assessed by 2x24h dietary recall using the INTAKE24 software.

*Results:* Adolescents reported having higher intention to eat healthy food and PBC over eating them comparing to unhealthy food. They also reported having more healthy food available at home, being more favourable and feeling more similar to a healthy prototype when comparing to unhealthy measures. However, they are more tempted and tended to eat more unhealthy food compared to healthy food. In terms of the food choice task results revealed that adolescents' choices seemed equally distributed between healthy and unhealthy food. When exploring group differences results revealed that: 1) boys and girls present similar results on the assessed variables; 2) healthy weight group presented higher scores in predictors related to unhealthy eating (i.e. higher intention, temptation, prototypes and availability at home) although they feel more similar to a healthy eater prototype compared with adolescents who were at least

overweight; and, 3) the most deprived group reported being less tempted to eat healthy foods and to healthy eating.

*Conclusions:* Despite a higher intake of unhealthy food, adolescents tended to be more favourable to healthy food-related predictors. Sex was not a relevant factor in distinguishing predictors of eating behaviour. Deprivation level and weight status revealed some differences. Results will be discussed at the end of the chapter.

### 3.1.2 Introduction

Adolescence is an important period of life to explore making decisions related to food. This developmental stage is characterised by increased levels of autonomy (Erikson, 1968). Some studies have found that eating patterns tend to decline in quality from childhood to adolescence (Story et al., 2002). This decline may be a result of higher levels of autonomy that result in adolescents receiving money (from parents, 1st job, etc.) and often spending it on unhealthy snacks and sweets (Darling et al., 2006; Farrell & Shields, 2007; Stok et al., 2010). The Health Survey England 2013, a national survey, reported that the intake of FV tended to decline at the age of 11-12 years (Caireen, 2014; Health and Social Care Information Centre, 2015). This survey also found that girls and adolescents living in least deprived areas tended to eat more FV. Similarly, the Health Behaviour in School-aged Children (HBSC) assessing children and adolescents in 40 countries found that 11-15 years is a critical age where intake of fruits decreases (Currie et al., 2012). In this European wide survey boys reported eating significantly less fruits than girls in around three quarter of countries. Further, they found that adolescents living in a deprived area have reported eating less fruits. Other studies have found that living in less affluent areas, does not only have a negative influence on fruit and vegetable (FV) intake but seems also positively associated with unhealthy (high sugar, high fat) food intake (Craig et al., 2010; Rasmussen et al., 2006; van Sluijs et al., 2008).

In everyday life, people are continuously exposed to stimuli depicting palatable and energy dense foods (Wardle, 2007) but individual differences on response-tendencies to food stimuli might affect distinct patterns of food intake and consequent body weight. Indeed, eating behaviours are influenced by a complexity of individual, social and environmental factors that shape people's decisions (Sallis et al., 2008), and decisions about what to eat are not an exception.

Health behaviour theories have provided useful insight into the explanation of predictors influencing eating behaviours. For example, dual-process models have identified two systems of processing information (Evans & Stanovich, 2013; see Evans, 2008 for a review). Using the terminology defined by the Reflective-Impulsive Model (Strack & Deutsch, 2004), the reflective system is responsible to process deliberative decisions whereas the impulsive system processes information automatically. For example, the reflective system allows people, who want to lose weight, to choose a salad, whereas the impulsive system allows people enact their desire of eating the burger. Research has revealed that executive function, such as, inhibitory control, may influence these two systems by exerting their influence on behavioural choice (e.g. Allan, Johnston, & Campbell, 2011; Hall, Fong, Epp, & Elias, 2008; Hofmann, Friese, & Roefs, 2009). Executive function also plays a direct role on eating behaviours. Some laboratory-studies testing attentional bias (part of the executive function) towards food showed that visual stimuli might increase anticipated pleasure, enhancing willingness to eat (Castellanos et al., 2009). Previous research in this area indicate that obese adolescents tend to pay more attention to food related stimuli (Soetens & Braet, 2007). However, no studies were found in comparing the attention of adolescents on healthy vs. unhealthy food. In addition, some evidence has shown that lower inhibitory control skills (part of the executive function) are associated with unhealthier eating behaviours and higher BMI (Allan et al., 2008, 2010; Nederkoorn et al., 2006). Further details on dual-process model and executive function can be found in chapter 3.2.

Most of the research done so far focuses on a limited number of predictors and very few studies have reported descriptive results on predictors of eating behaviours, which hinders possible comparison between these.

This chapter is focused on adolescence (12-13 years) assessed in a sub-sample followed in a birth cohort study – the Gateshead Millennium Study (GMS). The general aim of this chapter is to describe a set of individual, social and environmental factors assessed in relation to two behaviours: food choice and food intake. Food intake was divided in two sub-groups: healthy eating and unhealthy eating (see glossary). Another general aim of this chapter is to explore the way some of the predictors of eating behaviours differ when considering: sex, levels of deprivation and weight status and type of food-related predictor (e.g. intention to eat healthy food vs. intention to eat unhealthy food).

For the purpose of the present chapter, the terminology of the Reflective-Impulsive Model (Strack & Deutsch, 2004) was used (chapter 3.2 for more details on this theory).

### 3.1.3 Aims

The specific aims of this chapter are to:

- Aim 1: Explore relationships between age, weight status, level of deprivation, executive function, predictors related to healthy food, food choice and healthy eating
- Aim 2: Explore relationships between age, weight status, level of deprivation, executive function, predictors related to unhealthy food, food choice and unhealthy eating
- Aim 3: Explore differences in all variables between boys and girls;
- Aim 4: Explore differences in all variables between healthy weight and overweight/obese participants;

– Aim 5: Explore differences in all variables between four multiple levels of deprivation;
– Aim 6: Explore differences between predictors related to healthy food and predictors related to unhealthy food.

### 3.1.4 Method

#### *Participants and Procedures*

The ethical approval from Newcastle University Research Ethics Committee (00510/2011 and 00523/2012_2) was received in May 2012. The present research analysed a sub-sample of the Gateshead Millennium study (GMS; Parkinson, Pearce, et al., 2011), a British birth cohort study following 1029 children born in 1999/2000. The GMS collected information on the first year of life, during childhood and adolescence in several waves (15 altogether).

This chapter used data collected by the GMS in 2012 (15$^{th}$ wave), when participants were aged 11-13, which consisted of three face to face assessments. The first two assessments were part of the standard assessment procedures of the GMS where food intake was assessed by a 24h recall (INTAKE24, Foster et al., 2014). During the standard consent procedures, parents and adolescents were invited to take part to an optional food choice sub-study. Between August 2012 and March 2013, those parents who had consented (n=367) were contacted. After providing full information about a food choice sub-study, a total of 303 (82.56%) parents/adolescents consented/assented to participate in the sub-study which took place one to six months after the second visit of wave 15. Of the 303 participants, only 274 were assessed on food intake at the standard assessment procedures of the GMS (mostly due to the absence of the participants at school during data collection).

In order to offer families the option of data collection on school premises, collaborating GMS schools were contacted. Eight of the nine schools agreed to participate. Overall, 64% of participants were assessed in their schools, 35% were assessed at home and 1% was

assessed at Newcastle University. There were no statistically significant differences between the main characteristics of the GMS sample of answering the 15th wave (n= 525) and the sample reported on in this chapter regarding age (*p*=.13), weight status (*p*=.69) and sex (*p*=.90) and deprivation level (*p*=.91).

### *Measures*

For the purpose of the present chapter, some standard measures from the GMS were included in addition to the measures collected for the sub-study in order to answer the aims (appendix E).

#### *Standard GMS measures:*

*Sex* of the participants was recorded.

*Level of deprivation*: postcodes of participants and their families were collected. The postcodes were converted to the IMD 2007 using the UK data service census support website (http://geoconvert.mimas.ac.uk/). IMD measures deprivation levels in England based on the geography Lower layer Super Output Area (LSOA) where the most deprived LSOA for each Index is given a rank of 1 and the least deprived LSOA is given a rank of 32,482 (Noble et al., 2007). For the purpose of the present chapter, the IMD ranks were divided in quartiles by dividing the British ranks into quarters and allocating each GMS participant to the respective quartile according to IMD rank. More deprived areas are represented in the lower quartiles and higher quartiles represent less deprived areas.

*Weight status*: Height was measured to 0.1 cm with a Leicester Portable height measure and weight measured to 0.1 kg with a TANITA TBF 300MA. Body mass index (BMI) was calculated and classified as obese, overweight or healthy weight according with the IOTF growth chart cut-offs – called BMI z-scores – which takes into account the age, sex, height and weight of the participant (Cole et al., 2000). Two participants declined to be measured.

*Food intake* was assessed through a 24h recall in order to assess the frequency of healthy and unhealthy food (that can be eaten as a snack) intake on an average per day. This measure was also integrated in the standard measures of GMS. However, it will be described in the eating behaviours section (below) in order to facilitate the reading.

***Predictors measured in the food choice sub-study:***

*Reflective measures*

Intention and perceived behavioural control were evaluated as they have been identified as the most proximal variables to predict behaviour according to the dominant health behaviour theories (e.g. Ajzen, 1991). Three items each were used to assess intention to eat healthy (e.g. I intend to eat fruits and/or vegetables as snacks, between main meals; $\alpha$ = .71) and unhealthy food (e.g. I intend to eat sweet/savoury snacks, between main meals; $\alpha$ = .71). Perceived Behavioural Control (PBC) was assessed with three items for healthy food (e.g. If I wanted to I could eat fruits and/or vegetables as snacks, between main meals; $\alpha$ = .51) and two items for unhealthy food (e.g. If I wanted to I could eat sweet/savoury snacks, between main meals; $\alpha$ = .63). The intention and PBC items were based on standard assessment procedures (based on Ajzen, 2002) and responses were given on a five point scale (from 1 = definitely true to 5 = definitely not true) and scaled as the average response across items (separately for healthy and unhealthy). Higher scores indicated higher level of intention and PBC.

*Impulsive Measures*

*Temptation:* Fifteen healthy foods and 15 unhealthy foods that can be eaten as snacks that were mostly eaten by children aged 11-12 in the North East of England (Adamson et al., 2011)[4] were selected to be used within the impulsive measures – Table 3.1-1 – and a picture

[4] Participants in the Adamson et al., 2011 study were very similar to the study in the current chapter and did not differ regarding sex ($p$=.43) and BMI ($p$=.06). However, the sample of the present study lived in more deprived areas ($p$<.001).

of each food was produced (see appendix F) to assess *temptation.* Participants were asked to evaluate 15 healthy ($\alpha$ = .84) and 15 unhealthy foods ($\alpha$ = .87) according to the level of temptation attributed to the food represented in the image: "To me, [food illustrated on the screen] is a temptation, difficult to resist eating"; 1 = strongly disagree; 5 = strongly agree (based on Kroese, Adriaanse, Evers, & De Ridder, 2011). Scales for statistical analysis were computed using the average of the items (separately for temptation to eat healthy and unhealthy food). Higher scores indicated higher level of temptation.

**Table 3.1-1 – Food selected for measuring temptation and attentional bias.**

| Healthy | Unhealthy |
|---|---|
| Apple; | Boiled sweets; |
| Banana; | Crisps; |
| Carrot; | Flapjack; |
| Kiwi; | Chocolate cake; |
| Orange; | Chocolate biscuits; |
| Grape; | Sausage roll; |
| Pear; | Pizza; |
| Cherry; | Chips; |
| Strawberry; | Digestive biscuits; |
| Tomato; | Jellies; |
| Cucumber; | Crispy cake; |
| Raisins; | Coco pops; |
| Pineapple; | Potato waffle; |
| Peach; | Chocolate; |
| Melon; | Cereal bar; |

*Prototypes:* Two prototypical images of 1) adolescents who frequently eat healthy food and 2) adolescents who frequently eat unhealthy food were assessed based on recommendations by Gibbons and Gerrard (1995). *Prototypes evaluation* was assessed by asking the participants to give their opinion about healthy prototypes (e.g. what's your opinion about the type of person of your age who eats fruits and/or vegetables as snacks between main meals?) and unhealthy prototypes (e.g. what's your opinion about the type of

person of your age who eats sweet/savoury snacks between main meals?). The answer was given by the 'evaluation thermometer' on a 0-100% scale (0% do not approve at all and 100% completely approve). Higher scores indicated a favourable opinion about the prototype. *Prototype similarity* was assessed by asking the participants to report how similar they felt to each prototype on a five point scale (e.g. for the healthy prototype: 'In general, how similar are you to the type of person your age who eats fruits and/or vegetables as snacks between main meals?' 1= not at all similar to 5= very similar). The same item was developed for the unhealthy prototype. Higher scores indicated that adolescents felt more similar to the prototype assessed.

*Executive Function measures:*

*Attentional Bias towards food*: A Visual Dot Probe task, through Inquisit software© (www.millisecond.com/), was used to measure attentional bias to food stimuli (Maner, Gailliot, & DeWall, 2007). The 15 healthy and 15 unhealthy foods selected to assess temptation were used to assess attentional bias (list of the food is described in Table 3.1-1 and the images can be found in appendix F). In this task, a fixation cross emerged in the centre of the first screen (+) for 1000 ms on a 13.3" screen laptop (see Figure 3.1-1 and Figure 3.1-2). After this, a target (food picture) was displayed for 500 ms in one quadrant of the screen (i.e., upper left, upper right, lower left, lower right). Concurrent with the disappearance of the target, a randomized object (circle or triangle) appeared in either the same location as the picture (filler trials – Figure 3.1-1) or in a different quadrant (attentional shift trials – Figure 3.1-2 ). When this object appeared, the participant's task was to categorize the object as a circle or triangle, by pressing, respectively, the "C" or "T" key on the keyboard. After the response, a break of 2000 ms before the next trial was provided.

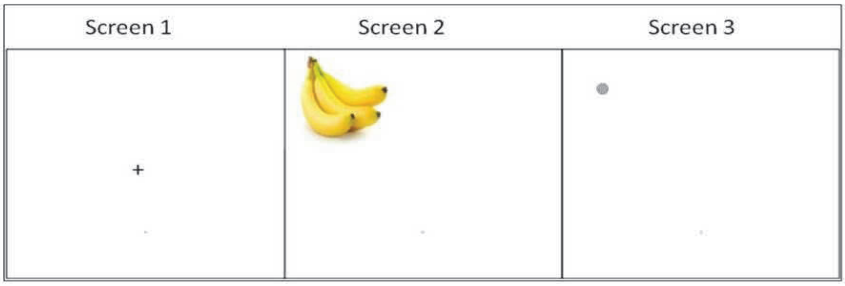


**Figure 3.1-1 Visual Dot Probe task – Example of a filler trial**

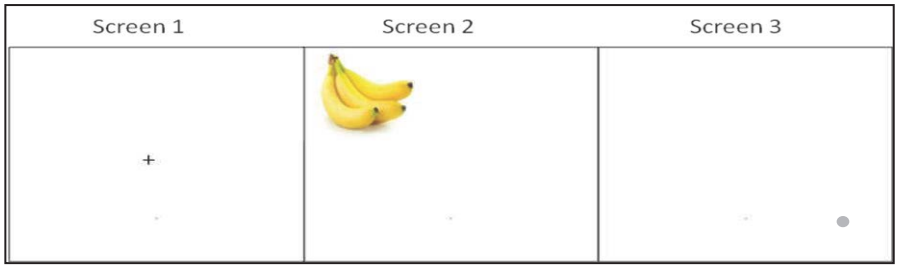


**Figure 3.1-2 - Visual Dot Probe task – Example of a shift trial**

Each participant completed a practice block of 10 neutral pictures (e.g. non-related food pictures) and 3 blocks of 10 experimental trials. Each trial included 5 pictures of healthy and 5 of unhealthy food presented randomly. Each block comprised 25% of filler trials and 75% of shift trials (trials of interest).

As in previous research (Maner et al., 2007) using this paradigm, the incorrect responses of categorizing the object (circle or triangle) and average response times in the extreme tail of the distribution (greater than 3.5 *SD*'s above the mean) were excluded from analysis ($N$ = 3; 1% in the present study). The rationale for this exclusion is that the failure to correctly categorise the simple shapes or respond within a reasonable length of time is signalling a failure of the participant to engage with the task. There is agreement among the community of researchers using these tasks that the inclusion of these results within the data set would merely add noise (Maner et al., 2007).

With this procedure, it was possible to assess the response latencies, i.e., the time between when the object (circle or triangle) appeared on the screen and the moment when the participant categorised the object during the shift trials. This measure was particularly important to assess the ability of the participant to shift

from a picture to an object in order to evaluate which type of food best captured the participant's attention. In contrast, the filler trials were designed to make sure that the participant remained focused in the pictures.

*Inhibitory Control* was assessed using the stop-signal paradigm in the Inquisit software©, on a 13.3" screen laptop. This involved two concurrent tasks: a go-task and a stop-task (Verbruggen, Logan, & Stevens, 2008). During the go-trials participants were instructed to discriminate whether an arrow was pointing to the left or to the right, pressing the "D" (left) or "K" (right) key on the keyboard as fast as possible depending on the direction of the stimulus (the arrow). In turn, the stop-trials involved the presentation of an auditory signal that indicated to participants to inhibit their response to the arrow (Figure 3.1-3)

Each participant completed one practice block of 32 practice trials followed by 3 blocks of 64 actual trials each which included 25% of stop-trials. All blocks started with a fixation sign which remained for 250 ms, subsequently the stimulus (i.e. the arrow) appeared until the participant responded or until 1250 ms had passed. An interval of 2000 ms was included between the stimulus and of 10 seconds between blocks.

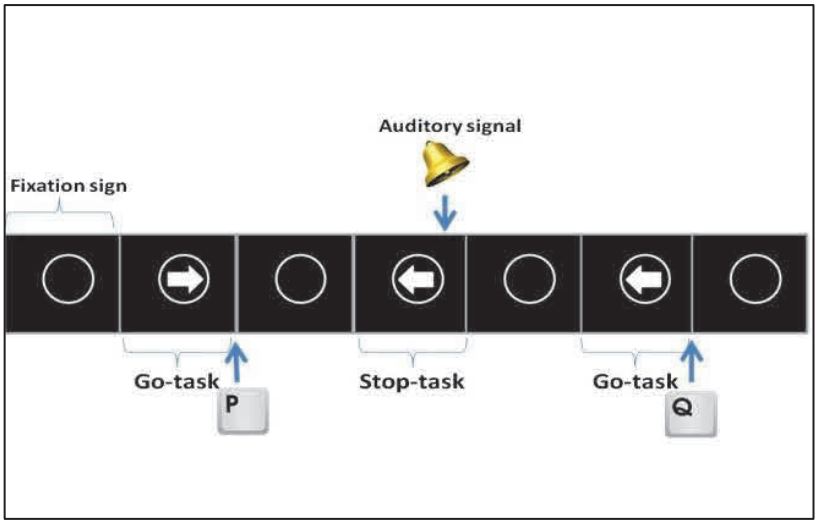


**Figure 3.1-3 - Stop-Signal Task procedure**

Reaction time to respond to the stimulus was recorded. The stop-signal was presented in a variable stop signal delay (SSD), i.e. the delay between the go-task stimulus (arrow) and the stop signal (auditory signal). At first, the SSD occurred at 250 ms and was adjusted continuously according to the performance of the participant: when the inhibition was successful the SSD increased by 50 ms, however, when the inhibition failed the SSD decreased by 50 ms. Also, the software estimated a stop-signal reaction time (SSRT) by subtracting mean SSD from the mean reaction time (Logan, Schachar, & Tannock, 1997). SSRT is the most important variable of this task, and was inverted for a better understanding of the results. That is, lower scores indicating less inhibitory control skills. Five participants were excluded due to hardware problems.

*Environmental measures:*

*Availability of food at home*: was assessed by asking the participants to rate the availability of healthy (How often do you have fruits and/or vegetables as snack at home?) and unhealthy food (How often do you have sweet/savoury snacks at home?) at home (adapted from Neumark-Sztainer et al., 2003) and the access to both types of food that parents gave them (How often do your parents give you fruits and/or vegetables to eat as a snack between main meals? And same question for unhealthy food). Therefore, this variable included 2 items ($\alpha$ = .64 for both type of food) for each type of food and ratings were

given on a five points scale, from never (1) to always (5). Higher scores reveal more availability of food at home.

*Outcomes: Eating behaviours*

*Food choice:* The Behavioural Choice Task © (Lappalainen & Epstein, 1990) was used to assess food choice. Before task was initiated participants were asked: "At this moment, how hungry are you?"; scaled 1 = not at all to 5 = very much (Piech, Pastorino, & Zald, 2010). This allowed controlling hunger in the statistical analysis and guarantying that the choice was not influenced by hunger. To conduct the task a selection of 8 food images with good availability across seasons for each type of food (from the 15 healthy and unhealthy foods selected for assessing temptation and attentional bias – Table 3.1-1 – Adamson et al., 2011) was used. The healthy food options were 1) apple, 2) banana, 3) carrot, 4) kiwi, 5) orange, 6) grape, 7) pear, 8) cucumber and the unhealthy food options were 1) boiled sweets, 2) crisps, 3) flapjacks, 4) chocolate biscuits, 5) jellies, 6) crispy cake, 7) coco pops, 8) chocolate. Before the task, portions of each food were shown in a picture (see appendix G) to make sure that participants understood the type and size of each reward. Participants had the chance to choose between both types of food before each of the trials. The task consists of two sets of three boxes in which different shapes and colours rotate every time the mouse button is pressed (like a slot machine) – Figure 3.1-4. The participant gets one point every time the shapes match in colour and shape. It was also explained that 15 points (each trial) earned would be exchanged for 1 portion of a chosen food. The task included 5 trials.

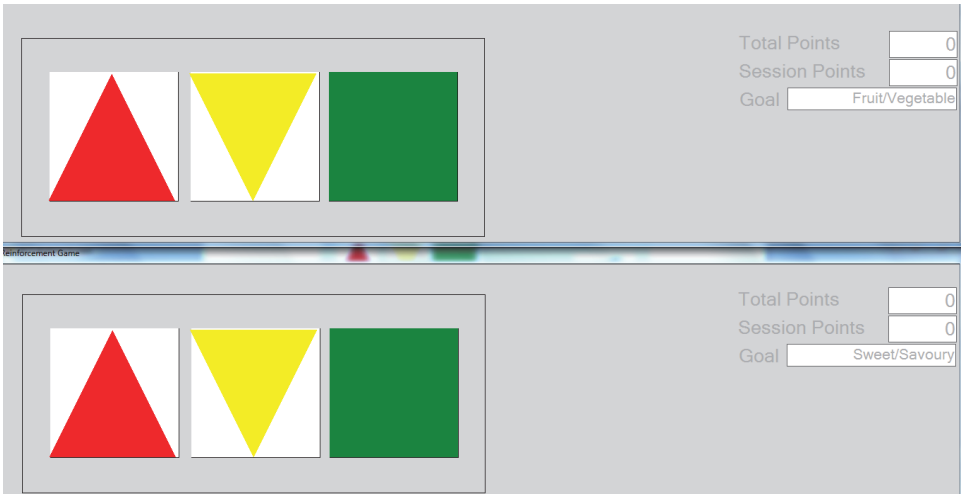


**Figure 3.1-4 – Behavioural Choice Task**

The task began with a concurrent schedule VR2/VR2 (the participants got on average one point every 2 responses for both schedules, i.e. for either choice: healthy or unhealthy food), after this, schedules doubled across the four subsequent trials from VR4 to VR32 for the reinforcer (i.e. healthy or unhealthy) chosen and consequently behavioural costs increased. However, the schedule remained the same when the reinforcer was not chosen. Therefore, the adolescents chose those foods that more motivated them to work on the task.

This task allowed calculating the amount of each type food chosen; scale ranging from 0 to 5 portions. Because the total amount of food after the task (5 trials) can only be 5 portions, if the amount of healthy food portions is known, (e.g. 3 portions of the healthy option achieved by the end of the task) then the amount of unhealthy portion of food can easily be calculated (2 portions of unhealthy portions). For this reason, only data from healthy food will be reported from here on for this specific variable (food choice).

*Food intake* was part of the standard measures of GMS which was measured retrospectively using a 24h recall food diary collected via INTAKE24 software (Foster et al., 2014). This software follows the 24h multiple pass recall procedure and allows participants to report all food and drinks consumed in the preceding day (from before

breakfast to after the evening meal), as well as the amount consumed (portion size) and time. Each participant completed 2 x 24h recalls with at least one week interval between both assessments. Fifty eight participants completed only one 24h recall. The output used for the present study was the average frequency of healthy and unhealthy food (list of food included can be found in the appendix A).

### 3.1.5 Statistical Procedure

For data analysis the Statistical Package for the Social Sciences 19 (SPSS) was used.

Internal consistency of responses to the scales was assessed using Cronbach's alpha (Cronbach & Meehl, 1955) and reported in the measures section. For the first and second aim of this chapter a Pearson inter-correlation between weight status, level of deprivation, executive function, food choice predictors related to healthy food and healthy eating (aim 1) or predictors related to unhealthy food and unhealthy eating (aim 2). Aim three and four were explored by conducting t-tests, in order to explore differences in all variables between groups by sex and weight status. Aim five was tested by conducting an ANOVA test where the differences in all variables between the four levels of deprivation were explored. When significant differences were found in the ANOVA analysis, post-hoc tests were done using Hochberg's GT2 alpha that takes into account the different sample sizes between the groups (Field, 2009). And finally, in order to test the sixth aim, paired sample T-test was used to compare measures related to healthy and unhealthy food.

Confidence intervals and the *p*-values of the tests will be reported in order to analyse the significance level.

### 3.1.6 Results

The present study assessed 303 adolescents (51.2% of girls) aged 12-13 years old ($M$ = 12.53, $SD$ = .50). IMD quartiles are shown in

Table 3.1-2. Most of the participants came from higher deprivation areas (67.4% in quartile 1 and 2). According the IOTF classification, 7.3% of the participants were obese, 24.3% were overweight and 68.4% were included in the healthy weight group. Comparing this results with those found in the National Child Measurement Programme (NHS Information Centre, 2013), there was no differences in the proportion of obese (*p*=.656) and healthy weight (*p*=.052) adolescents, however, the sample described in the present chapter presented more overweight participants (*p* =.006).

**Table 3.1-2 – Frequency of the IMD quartiles (level of deprivation)**

| IMD Quartiles | General Sample | |
|---|---|---|
| | *N* | % |
| 1.00 | 126 | 42.9 |
| 2.00 | 72 | 24.5 |
| 3.00 | 58 | 19.7 |
| 4.00 | 38 | 12.9 |

In order to verify that the computer tasks performed as expected, some analyses were done. In the Stop-Signal Task, the participants responded correctly in 92.8% (*SD* = 6.54) of the go-trials. This shows that the task was well understood by the adolescents. In the Visual Dot Probe task, filler trials and shift trials were compared through a paired T-test. Result demonstrated that there were no significant differences on reaction time between both trials (healthy food trials: *p*=.76; unhealthy food trials: *p*=.72) which might indicate that this task might have not performed as expected. This concern will be discussed in the limitations section.

### *Aim 1: Explore relationships between age, weight status, level of deprivation, executive function, predictors related to healthy food, food choice and healthy eating.*

Some correlations between the variables are low (between -.3 to .3) – Table 3.1-3. However, some moderate to high correlations were found indicating that:

- Food choice was positively correlated with the intention ($r = .31$; $p < .001$) and temptation ($r = .30$; $p < .001$) to eat a healthy food.
- Intentions to eat healthy food were positively associated with perceived control over eating ($r = .42$; $p < .001$), temptation ($r = .39$; $p < .001$), feeling similar to a healthy prototype ($r = .34$; $p < .001$), and availability at home ($r = .51$; $p < .001$).
- Perceived behavioural control (PBC) over eating healthy food was positively associated with the evaluation of a healthy prototype ($r = .32$; $p < .001$) and availability of this type of food at home ($r = .37$; $p < .001$)
- The more tempted to eat healthy food the more the adolescents reported having these available at home ($r = .47$; $p < .001$).
- Those reporting higher similarity with a healthy eater prototype tended to have healthy food more frequently available at home ($r = .43$; $p < .001$).

### *Aim 2: Explore relationships between age, weight status, level of deprivation, executive function, predictors related to unhealthy food, food choice and unhealthy eating*

Food choice and food intake outcome variables only presented low correlations with the assessed predictors – Table 3.1-4. However, some moderated and high correlations between the predictors were found:

– Intentions to eat unhealthy food were positively related to perceived behavioural control (r = .44; p <.001) and availability at home (r = .42; p <.001), as well as with feelings of similarity to an unhealthy prototype (r = .45; p <.001).
– Perceived behavioural control to eat unhealthy food was positively correlated with evaluation (r = .30; p <.001) and similarity to unhealthy prototype (r = .34; p <.001), as well as with availability of unhealthy food at home (r = .46; p <.001).
– Temptation to eat unhealthy food was positively related to availability of this food at home (r = .33; p <.001).
– The favourable evaluation of an unhealthy prototype and the similarity feeling to this tended to be associated with availability of unhealthy food at home (r = .33; p <.001; r = .42; p =.001 – respectively).

**Table 3.1-3 – Inter-correlation table between age, weight status, level of deprivation, executive function, predictors related to healthy food, food choice and healthy eating.**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. Food Choice** | | | | | | | | | | | | | |
| **2. Food Intake** | .23*** | | | | | | | | | | | | |
| **3. Age** | .03 | -0.06 | | | | | | | | | | | |
| **4. IMD (rank)** | -.01 | .18** | .01 | | | | | | | | | | |
| **5. BMI z-scores** | .10 | .00 | .09 | -.15* | | | | | | | | | |
| **6. Intention** | .31*** | .20** | .03 | .10 | .03 | | | | | | | | |
| **7. PBC** | .23*** | .15* | -.02 | .10 | -.09 | .42*** | | | | | | | |
| **8. Temptation** | .30*** | .17** | .05 | .14* | -.05 | .39*** | .24*** | | | | | | |
| **9. Prot. Evaluation** | .04 | 0.1 | -.01 | .01 | .03 | .21*** | .32*** | .07 | | | | | |
| **10. Prot. Similarity** | .17** | .13* | .06 | -.02 | -.10 | .34*** | .23*** | .29*** | .22*** | | | | |
| **11. Attentional Bias** | -0.06 | 0.02 | -.03 | -.03 | -.07 | .02 | -.08 | .07 | -.05 | .05 | | | |
| **12. Inhibitory Control** | -.21*** | -.20** | -.19** | -.06 | -.03 | -.18** | -.17** | .01 | -.15** | -.09 | .09 | | |
| **13. Availability** | .29*** | .17** | .04 | .10 | -.03 | .51*** | .37*** | .47*** | .18** | .43*** | .02 | -.12* | |
| Mean | 2.49 | 1.01 | 12.53 | 12033.81 | .72 | 3.37 | 4.03 | 2.80 | 71.01 | 3.27 | 754.70 | 521.06 | 3.36 |
| Standard Deviation | .91 | .77 | .50 | 8511.41 | 1.16 | .83 | .75 | .75 | 24.00 | 1.01 | 105.93 | 165.61 | .70 |

*Note: Food Choice and Food Intake are the frequency of healthy food eaten in the respective tasks; IMD = Index of Multiple deprivation; BMI = Body Mass Index; PBC= Perceived behavioural Control; Prot.= Eater Prototype; *p<.05; * *p<.01; ***p<.001.*

**Table 3.1-4 – Inter-correlation table between age, weight status, level of deprivation, executive function, predictors related to unhealthy food, food choice and unhealthy eating.**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1. Food Choice** | | | | | | | | | | | | | |
| **2. Food Intake** | .02 | | | | | | | | | | | | |
| **3. Age** | -.03 | -0.01 | | | | | | | | | | | |
| **4. IMD (rank)** | .01 | 0.03 | .01 | | | | | | | | | | |
| **5. BMI z-scores** | -.10 | -.12* | .09 | -.15* | | | | | | | | | |
| **6. Intention** | .29*** | .13* | .00 | -.05 | -.22*** | | | | | | | | |
| **7. PBC** | .14* | .21** | -.03 | .08 | -.13* | .44*** | | | | | | | |
| **8. Temptation** | .29*** | .12* | -.00 | .13* | -.18** | .27*** | .22*** | | | | | | |
| **9. Prot. Evaluation** | .19** | .06 | .04 | .13* | -.08 | .27*** | .30*** | .16** | | | | | |
| **10.Prot. Similarity** | .21*** | .17** | .03 | -.01 | .14* | .45*** | .34*** | .22*** | .28*** | | | | |
| **11.Attentional Bias** | .07 | .02 | -.04 | -.07 | -.01 | .04 | -.05 | .18** | -.16** | -.04 | | | |
| **12.Inhibitory Control** | .21*** | -.11 | -.19** | -.06 | -.03 | .11 | -.06 | .11 | .07 | .07 | .09 | | |
| **13.Availability** | .23*** | .27*** | .03 | .09 | -.22*** | .42*** | .46*** | .33*** | .33*** | .42*** | -.10 | .03 | |
| Mean | 2.51 | 1.68 | 12.53 | 12033.81 | .72 | 2.55 | 3.53 | 3.11 | 43.46 | 2.94 | 766.83 | 521.06 | 3.13 |
| Standard Deviation | .91 | .98 | .50 | 8511.41 | 1.16 | .79 | .77 | .72 | 25.49 | 1.01 | 116.28 | 165.61 | .70 |

*Note: Food Choice and Food Intake are the frequency of unhealthy food eaten in the respective tasks; IMD = Index of Multiple deprivation; BMI = Body Mass Index; PBC= Perceived behavioural Control; Prot.= Eater Prototype; *p<.05; * *p<.01; ***p<.001*

### *Aim 3: Explore differences in all variables between boys and girls:*

No differences were found between boys and girls (Table 3.1-5).

**Table 3.1-5 - Descriptive and differential tests results by Sex.**

| | Sex | | | |
|---|---|---|---|---|
| | Boys (*n*=148) *M* (*SD*) | Girls (*n*=155) *M* (*SD*) | *t (df)* | 95% CI |
| BMI z-score | .72 (1.25) | .73 (1.08) | .04(299) | [-.259; .270] |
| Hunger | 1.89 (.90) | 1.92 (.97) | -.75 (301) | [-.292; .132] |
| Intention (H) | 3.30 (.82) | 3.45 (.84) | 1.57(301) | [-.038; .338] |
| Intention (UH) | 2.57 (.86) | 2.54 (.72) | -.43(301) | [-.218; .140] |
| PBC (H) | 3.99 (.75) | 4.06 (.75) | .83(301) | [-.098; .241] |
| PBC (UH) | 3.51 (.81) | 3.56 (.74) | .95(301) | [-115; .326] |
| Temptation (H) | 2.81 (.77) | 2.80 (.73) | -.17(301) | [-.038; .338] |
| Temptation (UH) | 3.15 (.73) | 3.08 (.70) | -.87(301) | [-.218; .140] |
| Prototype evaluation(H) | 71.00 (24.07) | 71.01 (24.01) | .01(300) | [-.098; .241] |
| Prototype evaluationUH) | 43.27 (26.37) | 43.65 (24.71) | .13(300) | [-115; .326] |
| Prototype similarity (H) | 3.31 (1.02) | 3.24 (1.00) | -.57(299) | [-.295; .163] |
| Prototype similarity (UH) | 2.84 (1.09) | 3.03 (.92) | 1.58(300) | [-.316; .179] |
| Attentional Bias (H) | 768.31 (119.16) | 751.39 (113.89) | -1.26 | [-43.28; 9.428] |
| Attentional Bias (UH) | 775.05 (123.38) | 758.97 (108.90) | -1.20 | [-.42.36; 10.20] |
| Inhibitory Control | 219.87 (74.41) | 208.19 (62.70) | -1.47 | [-27.333; 3.970] |
| Availability (H) | 3.32 (.83) | 3.40 (.74) | .80 | [-.105; .250] |
| Availability (UH) | 3.09 (.73) | 3.16 (.67) | .83 | [-.091; .225] |
| Food choice (H) | 2.43 (1.00) | 2.54 (.82) | 1.08 | [-.094; .320] |
| Food Intake (H) | .91 (.72) | 1.10 (.81) | 1.96 | [-.001; .365] |
| Food Intake (UH) | 1.63 (.97) | 1.73 (.98) | .85 | [-.132; .334] |

*Note: H= healthy foods; UH= unhealthy foods; PBC= Perceived behavioural Control; BMI = Body Mass Index; *p<.05;*

### *Aim 4: Explore differences in all variables between healthy weight and overweight/obese participants*

All results of the t-tests can be found in the Table 3.1-6, however, only significant differences will be reported below.

*Hunger:*

Weight status groups were significantly different in their hunger level at the beginning of the assessment (t(299) = 3.04; *p* = .003; 95% CI [.122, .574]), showing that healthy-weight adolescents reported being significantly more hungry than their overweight/obese counterparts. However both scores were still under 2 in a 5 point lickert scale indicating very low levels of hunger.

*Reflective measures:*

Healthy-weight group reported higher levels of intention to eat unhealthy food (*t*(299) = 2.22; *p* = .28; 95% CI [.024, .408]) comparing with those who were at least overweight.

*Impulsive measures:*

Healthy-weight adolescents were significantly more tempted to eat unhealthy food (*t*(299) = 2.98; *p* < .003; ; 95% CI [.088; .432]) and evaluated the unhealthy prototype more positively (*t*(298) = 1.99; *p* = .48; ; 95% CI [.066; 12.463]). However, overweight/obese adolescents felt more similar to an unhealthy prototype comparing with the healthy-weight group (*t (298)*= -2.52; *p* = .12; 95% CI [-.558; -.069]).

*Home Environment measure:*

Healthy weight group reported having unhealthy food more frequently available at home (*t*(299) = 3.28; *p* = .001; 95% CI [.111; .447]).

**Table 3.1-6 – Descriptive and differential tests results by Weight Status.**

| | Weight Status | | | |
|---|---|---|---|---|
| | HW (*n*=206) *M* (*SD*) | OWOB (*n*=95) *M* (*SD*) | *t*(df) | 95% CI |
| BMI z-score | .14 (.87) | 1.99 (.55) | -19.17 (299)*** | [-2.043; -1.663] |
| Hunger | 1.99 (.95) | 1.64 (.87) | 3.04 (299)** | [.122; .574] |
| Intention (H) | 3.36 (.81) | 3.41 (.89) | -.53(299) | [-.256;.149] |
| Intention (UH) | 2.62 (.77) | 2.40 (.81) | 2.22(299)* | [.024;.408] |
| PBC (H) | 4.05 (.76) | 3.99 (.73) | .64(299) | [-.123;.241] |
| PBC (UH) | 3.57 (.78) | 3.47 (.75) | .68(299) | [-.156; .322] |
| Temptation (H) | 2.85 (.75) | 2.72 (.73) | 1.34(299) | [-.058; .306] |
| Temptation (UH) | 3.20 (.69) | 2.94 (.73) | 2.98(299)** | [.088; .432] |
| Prototype evaluation (H) | 70.82 (23.61) | 71.38 (25.13) | -.19(298) | [-6.445; 5.326] |
| Prototype evaluation(UH) | 45.58 (24.96) | 39.32 (26.26) | 1.99(298)* | [.066; 12.463] |
| Prototype similarity(H) | 3.35 (.95) | 3.13 (1.11) | 1.77(297) | [-.024; .468] |
| Prototype similarity (UH) | 2.83 (1.03) | 3.15 (.95) | -2.52(298)* | [-.558; -.069] |
| Attentional Bias (H) | 757.92 (122.46) | 763.86 (102.29) | -.41(299) | [-34.381; 22.485] |
| Attentional Bias (UH) | 764.72 (119.96) | 773.08 (107.99) | -.58(299) | [-36.756; 20.027] |
| Inhibitory Control | 213.61 (70.98) | 213.87 (64.72) | -.03(294) | [-17.230; 16.712] |
| Availability (H) | 3.40 (.79) | 3.30 (.79) | .98(299) | [-.096; .288] |
| Availability (UH) | 3.22 (.68) | 2.94 (.70) | 3.28(299)** | [.111; .447] |
| Food choice (H) | 2.43 (.87) | 2.61 (1.00) | -1.60(298) | [-.404; .042] |
| Food Intake (H) | 1.03 (.65) | 0.97 (.63) | .67(270) | [-.132; .266] |
| Food Intake (UH) | 1.74 (.89) | 1.56 (.92) | 1.42(270) | [-.070; .432] |

*Note: H= healthy foods; UH= unhealthy foods; BMI: body mass index; Weight Status classification according the IOTF: HW = healthy-weight; OWOB= Overweight and Obese; PBC= Perceived behavioural Control. *p<.05; **p<.01.*

### *Aim 5: Explore differences in all variables between the four deprivation levels*

All results of the ANOVA tests done to compare the four deprivation levels can be found in Table 3.1-7, however, only significant differences will be reported below.

*Weight status:*

ANOVA results showed significant differences between deprivation levels and BMI z-scores ($F(3,288) = 3.03$, $p = .030$). However, the Hochberg's GT2 post-hoc tests did not find significant differences between the groups. This indicates that there were significant differences between groups however post-hoc tests were not sufficiently sensitive to identify which groups significantly differed between one another.

***Impulsive measures:***

ANOVA tests demonstrated that the IMD groups were significantly different in the temptation towards healthy food ($F(3,290) = 3.41$, $p = .018$) and the similarity to a healthy prototype ($F(3,288) = 3.74$, $p = .012$). The Hochberg's GT2 post-hoc tests revealed that adolescents in quartile 1 were less tempted to eat healthy food ($2.66 \pm .71$; $p = .026$) than the 3rd quartile ($2.99 \pm .73$). It also shown that adolescents from quartile 3 perceive themselves as more similar to a healthy prototype ($3.54 \pm .83$; $p = .007$) than adolescents from the 4$^{th}$ quartile ($2.87 \pm 1.12$).

***Home Environment measure:***

ANOVA results revealed a significant difference between the IMD quartiles regarding the availability of healthy foods at home ($F(3,290) = 2.83$, $p = .039$). However, the Hochberg's GT2 post-hoc tests did not found any differences between the different quartiles.

**Table 3.1-7 - Descriptive and ANOVA results by IMD ranks quartiles (level of deprivation).**

| | IMD ranks | | | | |
|---|---|---|---|---|---|
| | 1st (*n*=126) *M* (*SD*) | 2nd (n=72) *M* (*SD*) | 3rd (*n*=206) *M* (*SD*) | 4th (*n*=95) *M* (*SD*) | *p* |
| BMI z-score | .81 (1.29) | .93 (1.03) | .48 (1.01) | .37 (1.15) | **.03*†** |
| Hunger | 1.89 (1.01) | 1.82 (.92) | 1.90 (.74) | 1.97 (1.03) | .87 |
| Intention (H) | 3.33 (.89) | 3.40 (.84) | 3.40 (.76) | 3.54 (.72) | .55 |
| Intention (UH) | 2.62 (.85) | 2.55 (.77) | 2.37 (.67) | 2.62 (.81) | .27 |
| PBC (H) | 3.96 (.80) | 4.08 (.72) | 4.20 (.66) | 4.04 (.69) | .21 |
| PBC (UH) | 3.38 (1.06) | 3.50 (.92) | 3.34 (.95) | 3.71 (.77) | .23 |
| Temptation (H) | 2.66 (.72) | 2.91 (.76) | 2.99 (.73) | 2.87 (.80) | .18 |
| Temptation (UH) | 3.04 (.76)a | 3.10 (.64) | 3.14 (.67)a | 3.32 (.78) | **.02*** |
| Prototype evaluation (H) | 70.43 (24.47) | 71.57 (22.73) | 72.30 (21.80) | 70.76 (29.25) | .97 |
| Prototype evaluation (UH) | 39.70 (26.21) | 43.42 (25.87) | 50.32 (21.74) | 44.21 (26.40) | .08 |
| Prototype similarity (H) | 3.22 (1.03) | 3.35 (.98) | 3.54 (.83)a | 2.87 (1.12)a | **.01*** |
| Prototype similarity (UH) | 2.95 (1.07) | 2.99 (.90) | 2.81 (97) | 3.03 (1.05) | .70 |
| Attentional Bias (H) | 762.53(109.47) | 777.12 (124.51) | 725.30 (98.16) | 772.93 (148.99) | .07 |
| Attentional Bias (UH) | 771.83 (120.90) | 777.60 (107.86) | 742.52 (116.67) | 761.55 (118.40) | .33 |
| Inhibitory Control | 215.48 (69.01) | 209.23 (67.82) | 213.82 (72.00) | 208.57 (65.63) | .91 |
| Availability (H) | 3.23 (.80) | 3.48 (.76) | 3.55 (.68) | 3.34 (.86) | **.04*†** |
| Availability (UH) | 3.12 (.73) | 3.01 (.60) | 3.15 (.66) | 3.33 (.76) | .16 |
| Food choice (H) | 2.42 (.96) | 2.64 (.86) | 2.60 (.96) | 2.32 (.57) | .18 |
| Food Intake (H) | .84 (.75)ab | 1.16 (.78)a | 1.16 (.74)b | 1.18 (.77) | **.01*** |
| Food Intake (UH) | 1.78 (.96) | 1.48 (.89) | 1.72 (1.07) | 1.82 (.98) | .20 |

*Note: H= healthy foods; UH= unhealthy foods; Weight Status classification according the IOTF: HW = healthy-weight; OWOB= Overweight and Obese; PBC= Perceived behavioural Control. BMI = Body Mass Index; IMD = Index of Multiple Deprivation. For each variable, group values with the same lowercase letters significantly differ from one another. * p= <.05; †Post-Hocs did not find any significant difference between the groups.*

*Outcomes: Eating Behaviours:*

*Food Intake:*

According to the level of deprivation level, adolescents have different behaviours regarding the healthy food intake ($F(2,262) = 4.38$; $p = .005$). Hochberg's GT2 Post-Hoc revealed adolescents from the quartile 1 have eaten significantly less healthy food ($.82 \pm .75$) than those in the quartile 2 ($p = .024$) and quartile 3 ($p = .043$).

### *Aim 6: Explore differences between predictors of healthy food and predictors of unhealthy food.*

All results of Paired-samples T-tests done to compare predictors related to healthy food and predictors related to unhealthy food can be found in the Table 3.1-8, however, only significant differences will be reported below.

*Reflective measures:*

Results indicate that adolescents reported having higher intention to eat healthy food ($t(302) = 11.51$; $p < .001$; 95% CI [.679; .960]) and perceived more behaviour control over eating them ($t(302) = 9.74$; $p < .001$; 95% CI [.481; .724]) when compared with same predictors related to unhealthy food.

*Impulsive measures:*

Adolescents reported feeling more tempted to eat unhealthy than healthy food ($t(302) = -6.27$; $p < .001$; 95% CI [-.407; -.213]). Adolescents evaluated a healthy prototype more positively ($t(301) = 13.37$; $p < .001$; 95% CI [23.487; 31.599]) and reported feeling more similar to it ($t(300) = 3.52$; $p < .001$; 95% CI [.147; .518) when comparing with an unhealthy prototype.

*Home Environment measure:*

Adolescents reported having more healthy food available at home ($t(302) = 3.83$; $p < .001$; 95% CI [.115;.357]) comparing with unhealthy food.

**Table 3.1-8 – Paired T-test comparing predictors related to healthy food and predictors related to unhealthy food**

| Pairs | Healthy foods *M (SD)* | Unhealthy foods *M (SD)* | *r* | *t*(df) | 95% CI |
|---|---|---|---|---|---|
| Intention | 3.37 (.83) | 2.55 (.79) | -.17** | 11.51(302)*** | [.679; .960] |
| PBC | 4.02 (.75) | 3.42 (.98) | .24*** | 9.74(302)*** | [.481; .725] |
| Temptation | 2.80 (.75) | 3.11 (.72) | .31*** | -6.27(302)*** | [-.407; -.213] |
| Prototype evaluation | 71.01 (24.00) | 43.46 (25.49) | -.05 | 13.37(301)*** | [23.487; 31.599] |
| Prototype similarity | 3.27 (1.01) | 2.94 (1.01) | -.32*** | 3.52(300)*** | [.147; .518] |
| Attentional Bias | 759.66 (116.61) | 766.83 (6.68) | .85*** | -1.94(302) | [-14.437; .097] |
| Availability | 3.36 (.79) | 3.13 (.70) | -.04 | 3.83(302)*** | [.115; .357] |
| Food Choice | 2.49 (.91) | 2.51 (.91) | -1.00*** | -.252 | [-.233; .181] |
| Food Intake | 1.01 (.77) | 1.68 (.98) | .084 | -9.28(273)*** | [-.812; -.528] |

*Note: PBC= Perceived behavioural Control. **p<.01***p<.001*

*Outcomes: Eating Behaviours:*

*Food Intake:*

The general sample have reported eating more unhealthy food when comparing with healthy food (*t* (273)= -9.28; *p*<.001; 95% CI [-.812; -.527]).

### 3.1.7 Discussion

This chapter aimed to describe individual, social and environmental predictors of eating behaviours (food choice and food intake) in a sub-sample of adolescents aged 12-13, as well as, to compare the results by sex, weight status and level of deprivation.

In terms of food intake the results found on this sample were consistent with the results of the Health Survey England (Caireen, 2014) and those reported on the cross European HBSC study (2004). Results from the HBSC revealed that adolescents consumed less than a third of the amount of fruits and vegetables daily guidelines recommend. This is a particular public health concern which must be addressed since a regular intake of fruits and vegetables reduces the risk of non-communicable diseases (WHO, 2002). Despite their higher intake and temptation towards unhealthy food, participants reported more favourable social cognitions (intention and PBC) to healthy food and healthy eater prototypes. This indicates the difficulty of applying this behaviour in real life. Regarding food choices, adolescents have chosen healthy and unhealthy food equally, and no differences were found according to their sex, weight status or level of deprivation on food choice.

Considering the differences between sub-groups, the results showed that boys and girls had similar results on the variables assessed. These results contrast with findings from earlier research that have consistently found that boys tend to eat less FV comparing with girls (Caireen, 2014; Currie et al., 2012; Rasmussen et al., 2006).

When analysing the differences between those overweight/obese and those in the healthy weight group, results revealed that the healthy weight group tended to present higher scores on predictors related to unhealthy food. One possible explanation for these results is that this group may be more allowed to eat more of this type of food because of their lower weight status. This hypothesis can be fortified by the fact that this group also reported having more unhealthy food available compared with their peers. However, these results could also be a product of some social desirability (e.g. participants who were overweight or obese when answering the questionnaire). The healthy weight group reported feeling less similar to unhealthy eater prototypes. Prior research has found that prototypes evaluations are often associated with body size and healthy prototypes are perceived as “slim and sporty” (Gerrits et al., 2009). Consequently, the healthy weight group might have associated themselves with healthy prototypes due to this criterion.

The differences observed in accordance to level of deprivation reveal that the most deprived group reported eating significantly less healthy food and presented higher BMI values. These results are in line with national surveys on level of deprivation and BMI (NHS Information Centre, 2013) as well as FV intake (Caireen, 2014). The most deprived group reported feeling less tempted to eat unhealthy food. Regarding perception of availability of healthy food at home, results are unclear. The post-hoc tests were not able to identify the groups that differed between each other, although the ANOVA presented significant differences. Further research is needed in this area. Finally, the most deprived group reported feeling less tempted to eat healthy food. This result may be due to the lack of previous experience with healthy food. Indeed, previous research has found that lower socio-economic status is associated with poorer diet (Craig et al., 2010; Currie et al., 2012; Rasmussen et al., 2006; van Sluijs et al., 2008).

### *Strengths and limitations*

Some limitations are, nevertheless present and should be addressed. First, social-cognitions were assessed using self-report measures and potential social desirability biases should be considered. Further, the fact that the researcher stayed in the same room during the experimental tasks might also have produced results influenced by social desirability (in terms of food choices), particularly when considering the overweight/obese participants who are often stigmatised and may feel more social pressure to choose to eat healthily. Third, in the visual dot probe task, filler trials and shift trials reaction times were not significantly different which might indicate that this task might have not performed as expected. This might have occurred because adolescents did not seem to have focus their attention on the picture but were more focused on the stimulus (triangle or circle) itself. In the future, it could be important to test the same procedure but altering the exposure time to the pictures. Furthermore adding an eye-track movement to the task to allow for an objective measure on the movement of the eyes should be considered. This task was adapted from a study using adults, exploring the specificity of this task in younger people would help to improve the performance of this task.

This study has a complex protocol involving several measures which will be integrated in statistical models in future chapters that will aim to better understand the role of these predictors on eating behaviours during adolescence. The present chapter was essential for describing the sample on the predictors and behaviours assessed.

To conclude, the present chapter reported descriptive and differential results that will allow further exploration and elaboration on the predictors of food choice and food intake in adolescents. These efforts will be reported in subsequent chapters.

# Chapter 3.2 Eating behaviours in 12-13 years old adolescents: An extended Dual Process Approach.

### 3.2.1 Abstract

*Aims:* The present chapter aimed to explore the role of reflective, impulsive, and executive function variables, based on a dual process model, as predictors of food choice and food intake in a sample of adolescents aged 12-13 years old.

*Methods:* 303 adolescents completed a questionnaire measuring: reflective [intention and perceived behavioural control (PBC) over eating (un)healthy food] and impulsive [(un)healthy eater prototypes and temptation to eat (un)healthy food] measures. Adolescents also completed a Stop-Signal Task in order to assess executive function (inhibitory control). Food intake was assessed via a 24h recall and food choice was assessed via Behavioural Choice Tasks. Here adolescents could chose to obtain a healthy or unhealthy food after responding to a series of trials. After the first trial, costs to obtain the same food increased trial after trial (5 trials).

*Results:* Hierarchical linear analyses showed that the final model of food choice accounted for 35.1% (adjusted $R^2$ = 29.9%). Temptation to eat both types of food and the interaction between temptation to eat unhealthy food and inhibitory control predicted significantly food choice. That is, more inhibitory control skills led to a higher amount of healthy food chosen. The final model of healthy eating accounted for 8.6% (adjusted $R^2$ = 4.6%), with inhibitory control as the only significant predictor. And the final model of unhealthy eating accounted for 8.3% (adjusted $R^2$ = 4.3%), with no significant predictors.

*Conclusions:* Temptation to eat seems to have a stronger influence on the food choice task when compared with intentions and PBC. Furthermore, inhibitory control interacts with temptation but only when considering unhealthy food. These results suggest that adolescents may benefit from interventions targeting temptation and inhibitory control over eating.

### 3.2.2 Introduction

The World Health Organisation recommends a regular intake of fruits and vegetables (FV) in order to reduce the risk of non-communicable diseases (WHO, 2002). Nevertheless, not many young people are meeting guidelines for fruit and vegetable intake (Bates et al., 2011; Health and Social Care Information Centre, 2014; Vereecken et al., 2004), whereas the intake of sweets and savoury snacks have increased over time in children and adolescents (Piernas & Popkin, 2010). A systematic review of psychosocial correlates of eating behaviours amongst children and adolescents (McClain et al., 2009) found evidence that both, social factors (e.g., modelling and norms) and individual factors (dietary intentions, liking and preferences) have consistent positive associations with eating behaviour. This review identified considerable gaps in the evidence base for adolescent eating behaviours due to: a) poor study methodology; b) overemphasis on rational/reflective processes; and, c) use of limited theoretical perspectives (excluding impulsive/implicit determinants of eating behaviours).

Dual process models have been helpful to understand psychological predictors of health behaviours. These models share the assumption of the existence of two different systems of processing information (Metcalfe & Mischel, 1999; Strack & Deutsch, 2004). For the purpose of the current chapter the terminology of the reflective-impulsive model (Strack & Deutsch, 2004) will be used. Strack and Deutsch (Strack & Deutsch, 2004) suggest an impulsive system and a reflective system. The first is triggered by impulses allowing people to act automatically with minimal effort. The former underlines reasoned processes to make decisions allowing people to control their own behaviour (Hofmann, Friese, & Strack, 2009), which is very similar to the dominant health behaviour theories assumptions (e.g. Ajzen, 1991; Bandura, 1978; Fishbein & Ajzen, 2010). In everyday life, people are often confronted with the conflict “reason vs. impulse” of having an immediate reward/pleasure (e.g. to eat an ice-cream) or

attain a long-term goal (e.g. to lose weight). Some evidence has shown that the impulsive system seems to have a greater influence on quick choices when people are under time pressure whereas the reflective system seems to be more associated with deliberative behaviours (Malte Friese, Wänke, & Plessner, 2006; Perugini, 2005). Furthermore, when studying adolescents, it is important to take into account social influences on behaviour. The prototype willingness model (Gibbons & Gerrard, 1995) presents evidence that adolescents behaviours are often more impulsive and socially driven. Gibbons and Gerrard (1995) suggest the existence of a rational path – similar to the reflective system acknowledged by the RIM or the dominant health behaviour theories (e.g. Ajzen, 1991; Bandura, 1978; Fishbein & Ajzen, 2010) – and a social reaction path. That is, some of the behaviours generated are automated reactions to cues triggered by a prototype, i.e. a person of the same age who behaves in a specific way (Gerrits et al., 2010). Therefore, adolescents may like or dislike a prototype (prototype evaluation) and compare themselves to the prototype (prototype similarity). If adolescents assess a prototype as positive and perceive themselves as similar to the image of the prototype there is some evidence that adolescents are more likely to engage in the behaviour performed by the prototype (Gibbons, Gerrard, Ouellette, & Burzette, 1998; Rivis & Sheeran, 2003). The very few studies conducted in adolescents' eating behaviour revealed that adolescents showed positive images of healthy eaters and negative images of unhealthy eaters, but only the identification with an unhealthy eater prototype predicted unhealthy eating practices (Gerrits et al., 2010, 2009).

People react differently to external cues or impulses, some are able to resist them but for others it is too hard. Strack and Deutsch (Strack & Deutsch, 2004) suggest that the "impulsive system is always engaged in processing (by itself or in parallel with operations of the reflective system) whereas the reflective system may be disengaged" (p. 223). In fact, situational or dispositional boundary conditions, can affect which of the two systems may prevail – see Figure 3.2-1, such

as trait of self-control, ego depletion, alcohol consumption, executive function, etc. (Hofmann, Friese, & Strack, 2009). Some research has explored the role of executive function on the relationship between behaviour and both systems (e.g. Allan et al., 2011; Hall et al., 2008; Hofmann, Friese, & Roefs, 2009). Executive function has three cores: inhibitory control; working memory and cognitive flexibility (Diamond, 2013). In the present chapter inhibitory control will be explored given its key role on the control of behaviour, thoughts and/or emotions (Diamond, 2013). Some evidence has shown that inhibitory control seems to have an important role on eating behaviour, with lower control skills associated with unhealthier eating behaviours and higher BMI (Allan et al., 2008, 2010; Nederkoorn et al., 2006). Furthermore, inhibitory control may also influence behaviour indirectly by interacting not only with factors on the reflective system (Allan et al., 2011; Hall et al., 2008; Honkanen, Olsen, Verplanken, & Tuu, 2012) but also with those on the impulsive system (Hofmann, Friese, & Roefs, 2009; Honkanen et al., 2012). However, little is known about the influence of executive function on both systems, integrated together, on the prediction of eating behaviours. Furthermore, research has been conducted mainly with adults, and it is unclear if similar relationships exist in younger samples. Nevertheless, better understanding on how these components together influence not only unhealthy but also healthy eating, particularly in adolescence, would help to improve future prevention programs.

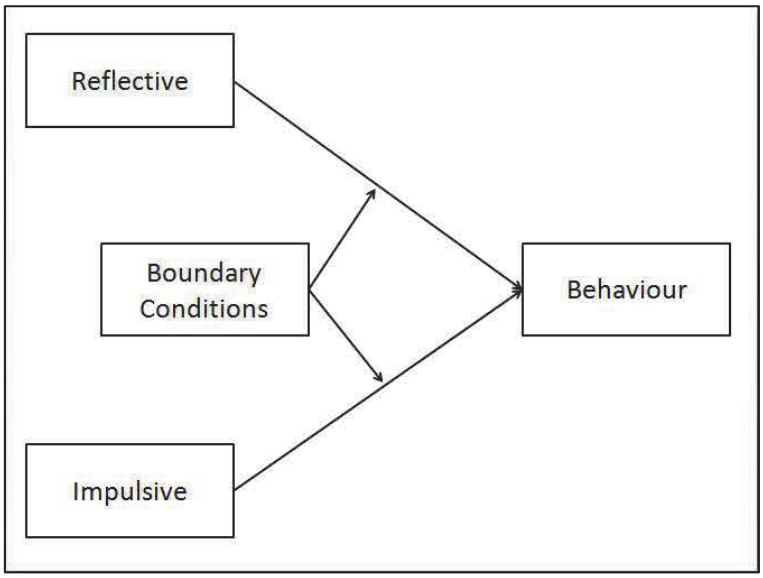


**Figure 3.2-1 - Dual-process model**

It is hypothesised that certain behavioural outcomes might be more prompt by reflective systems and others by impulsive systems. Social cognitions (reflective system) about behaviours are reasonably stable over time (Araújo-Soares et al., in press; Rhodes, Macdonald, & McKay, 2006). Some of the factors that are part of the impulsive system may be more temporal (e.g. temptation: 'It is warm outside, I am hungry, so, I want to eat this ice-cream now!', but might change later, in a different context). Therefore, the influence of the reflective and impulsive systems may be distinct when predicting a choice made relatively quickly vs. "regular" behaviour (where people have on average more time to decide). Better understanding of these assumptions in eating behaviour is important.

### 3.2.3 Aims

The three research questions explored in this chapter were:

- Aim 1: Do reflective and impulsive predictors have an influence on food choice and food intake (healthy and unhealthy eating) in adolescents?
- Aim 2: Does inhibitory control predict these behaviours?

– Aim 3: Does inhibitory control moderate the relationship between eating behaviours and the reflective and impulsive predictors?

### 3.2.4 Methods

#### *Participants and Procedures*

The ethical approval from Newcastle University Research Ethics Committee (00510/2011 and 00523/2012_2) was received in May 2012. The present research analysed a sub-sample of the Gateshead Millennium study (GMS; Parkinson, Pearce, et al., 2011), a British birth cohort study following 1029 children born in 1999/2000. The GMS collected information on the first year of life, during childhood and adolescence in several waves (15 altogether).

This chapter used data collected by the GMS in 2012 (15$^{th}$ wave), when participants were aged 11-13, which consisted of three face to face assessments. The first two assessments were part of the standard assessment procedures of the GMS where food intake was assessed by a 24h recall (INTAKE24, Foster et al., 2014). During the standard consent procedures, parents and adolescents were invited to take part to an optional food choice sub-study. Between August 2012 and March 2013, those parents who had consented (n=367) were contacted. After providing full information about a food choice sub-study, a total of 303 (82.56%) parents/adolescents consented/assented to participate in the sub-study which took place one to six months after the second visit of wave 15. Of the 303 participants, only 274 were assessed on food intake at the standard assessment procedures of the GMS (mostly due to the absence of the participants at school during data collection).

In order to offer families the option of data collection on school premises, collaborating GMS schools were contacted. Eight of the nine schools agreed to participate. Overall, 64% of participants were assessed in their schools, 35% were assessed at home and 1% was assessed at Newcastle University. There were no statistically

significant differences between the main characteristics of the GMS sample of answering the 15th wave (n= 525) and the sample reported on in this chapter regarding age (*p*=.13), weight status (*p*=.69) and sex (*p*=.90) and deprivation level (*p*=.91).

### *Measures*

All measures can be found in appendix E.

#### *Reflective measures*

Three items each were used to assess *intention* to eat healthy (e.g. I intend to eat fruits and/or vegetables as snacks, between main meals; $\alpha$ = .71) and unhealthy foods (e.g. I intend to eat sweet/savoury snacks, between main meals; $\alpha$ = .71). *Perceived Behavioural Control* (PBC) was assessed with three items for healthy food (e.g. If I wanted to I could eat fruits and/or vegetables as snacks, between main meals; $\alpha$ = .51) and two items for unhealthy foods (e.g. If I wanted to I could eat sweet/savoury snacks, between main meals; $\alpha$ = .63). The intention and PBC items were based on standard assessment procedures (based on Ajzen, 2002) and responses were given on a five point scale (from 1 = definitely true to 5 = definitely not true) and scaled as the average response across items (separately for healthy and unhealthy). Higher scores indicated higher level of intention and PBC.

#### *Impulsive Measures*

*Temptation:* Fifteen healthy foods and 15 unhealthy foods that can be eaten as snacks that were mostly eaten by children aged 11-12 in the North East of England (Adamson et al., 2011)[5] were selected to be used within the impulsive measures – Table 3.2-1 – and a picture of each food was produced (see appendix F) to assess *temptation.* Participants were asked to evaluate 15 healthy ($\alpha$ = .84) and 15 unhealthy foods ($\alpha$ = .87) according to the level of temptation attributed to the food represented in the image: “To me, [food

[5] Participants in the Adamson et al., 2011 study were very similar to the study in the current chapter and did not differ regarding sex (*p*=.43) and BMI (*p*=.06). However, the sample of the present study lived in more deprived areas (*p*<.001).

illustrated on the screen] is a temptation, difficult to resist eating"; 1 = strongly disagree; 5 = strongly agree (based on Kroese et al., 2011). Scales for statistical analysis were computed using the average of the items (separately for temptation to eat healthy and unhealthy food). Higher scores indicated higher level of temptation.

**Table 3.2-1 – Food selected for measuring temptation.**

| Healthy | Unhealthy |
|---|---|
| Apple | Boiled sweets |
| Banana | Crisps |
| Carrot | Flapjack |
| Kiwi | Chocolate cake |
| Orange | Chocolate biscuits |
| Grape | Sausage roll |
| Pear | Pizza |
| Cherry | Chips |
| Strawberry | Digestive biscuits |
| Tomato | Jellies |
| Cucumber | Crispy cake |
| Raisins | Coco pops |
| Pineapple | Potato waffle |
| Peach | Chocolate |
| Melon | Cereal bar |

*Prototypes:* Two prototypical images of 1) adolescents who frequently eat healthy and 2) adolescents who frequently eat unhealthy foods were assessed based on recommendations by Gibbons and Gerrard (1995). *Prototypes evaluation* was assessed by asking the participants to give their opinion about healthy prototypes (e.g. what's your opinion about the type of person of your age who eats fruits and/or vegetables as snacks between main meals?) and unhealthy prototypes (e.g. what's your opinion about the type of person of your age who eats sweet/savoury snacks between main meals?). The answer was given by the 'evaluation thermometer' on a 0-100% scale (0% do not approve at all and 100% completely approve). Higher scores indicated a favourable opinion about the prototype. *Prototype similarity* was assessed by asking the

participants to report how similar they felt to each prototype on a five point scale (e.g. for the healthy prototype: 'In general, how similar are you to the type of person your age who eats fruits and/or vegetables as snacks between main meals?' 1= not at all similar to 5= very similar). The same item was developed for the unhealthy prototype. Higher scores indicated that adolescents felt more similar to the prototype assessed.

*Executive function*

*Inhibitory Control* was assessed using the stop-signal paradigm in the Inquisit software©, on a 13.3" screen laptop. This involved two concurrent tasks: a go-task and a stop-task (Verbruggen et al., 2008). During the go-trials participants were instructed to discriminate whether an arrow was pointing to the left or to the right, pressing the "D" (left) or "K" (right) key on the keyboard as fast as possible depending on the direction of the stimulus (the arrow). In turn, the stop-trials involved the presentation of an auditory signal that indicated to participants to inhibit their response to the arrow (Figure 3.2-2).

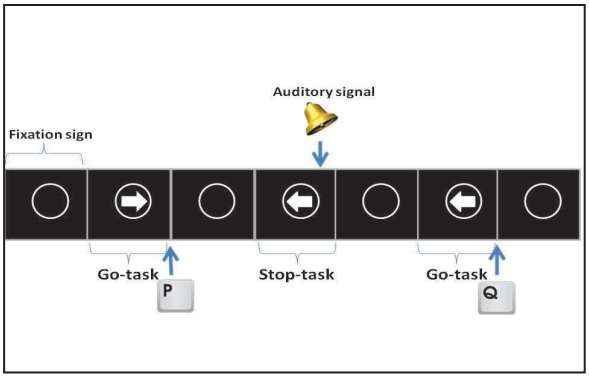


**Figure 3.2-2 – Stop-Signal Task procedure**

Each participant completed one practice block of 32 practice trials followed by 3 blocks of 64 actual trials each which included 25% of stop-trials. All blocks started with a fixation sign which remained for 250 ms, subsequently the stimulus (i.e. the arrow) appeared until the participant responded or until 1250 ms had passed. An interval of

2000 ms was included between the stimulus and of 10 seconds between blocks.

Reaction time to respond to the stimulus was recorded. The stop-signal was presented in a variable stop signal delay (SSD), i.e. the delay between the go-task stimulus (arrow) and the stop signal (auditory signal). At first, the SSD occurred at 250 ms and was adjusted continuously according to the performance of the participant: when the inhibition was successful the SSD increased by 50 ms, however, when the inhibition failed the SSD decreased by 50 ms. Also, the software estimated a stop-signal reaction time (SSRT) by subtracting mean SSD from the mean reaction time (Logan et al., 1997). SSRT is the most important variable of this task, and was inverted for a better understanding of the results. That is, lower scores indicating less inhibitory control skills. Five participants were excluded due to hardware problems.

*Outcomes: Eating behaviours*

*Food choice:* The Behavioural Choice Task © (Lappalainen & Epstein, 1990) was used to assess food choice. Before the task was initiated participants were asked: "At this moment, how hungry are you?"; scaled 1 = not at all to 5 = very much (Piech et al., 2010). This allowed controlling hunger in the statistical analysis and guarantying that the choice was not influenced by hunger. To conduct the task a selection of 8 food images with good availability across seasons for each type of food (from the 15 healthy and unhealthy foods selected for assessing temptation – Table 3.2-1 – Adamson et al., 2011) was used. The healthy food options were 1) apple, 2) banana, 3) carrot, 4) kiwi, 5) orange, 6) grape, 7) pear, 8) cucumber and the unhealthy food options were 1) boiled sweets, 2) crisps, 3) flapjacks, 4) chocolate biscuits, 5) jellies, 6) crispy cake, 7) coco pops, 8) chocolate. Before the task, portions of each food were shown in a picture (see appendix G) to make sure that participants understood the type and size of each reward. Participants had the chance to choose between both types of food before each of the trials. The task

consists of two sets of three boxes in which different shapes and colours rotate every time the mouse button is pressed (like a slot machine) – Figure 3.2-3. The participant gets one point every time the shapes match in colour and shape. It was also explained that 15 points (each trial) earned would be exchanged for 1 portion of a chosen food. The task included 5 trials.

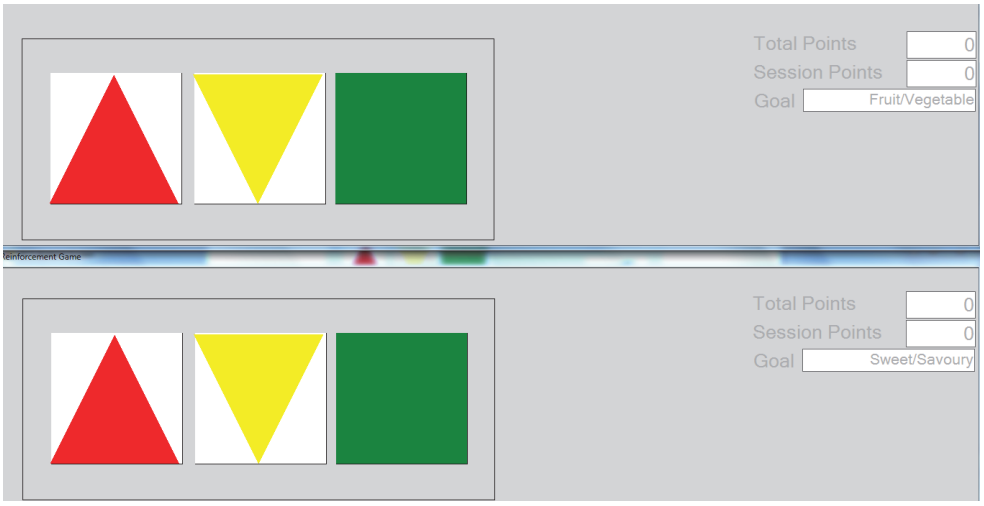


**Figure 3.2-3 – Behavioural Choice Task**

The task began with a concurrent schedule VR2/VR2 (the participants got on average one point every 2 responses for both schedules, i.e. for either choice: healthy or unhealthy food), after this, schedules doubled across the four subsequent trials from VR4 to VR32 for the reinforcer (i.e. healthy or unhealthy food) chosen and consequently behavioural costs increased. However, the schedule remained the same when the reinforcer was not chosen. Therefore, the adolescents chose those foods that more motivated them to work on the task.

This task allowed calculating the amount of each type food chosen; scale ranging from 0 to 5 portions. Because the total amount of food after the task (5 trials) can only be 5 portions, if the amount of healthy food portions is known, (e.g. 3 portions of the healthy option achieved by the end of the task) then the amount of unhealthy portion of food can easily be calculated (2 portions of unhealthy

portions). For this reason, only data from healthy food will be reported from here on for this specific variable (food choice).

*Food intake* was part of the standard measures of GMS which was measured retrospectively using a 24h recall food diary collected via INTAKE24 software (Foster et al., 2014). This software follows the 24h multiple pass recall procedure and allows participants to report all food and drinks consumed in the preceding day (from before breakfast to after the evening meal), as well as the amount consumed (portion size) and time. Each participant completed 2 x 24h recalls with at least one week interval between both assessments. Fifty eight participants completed only one 24h recall. The output used for the present study was the average frequency of healthy and unhealthy food (list of food can be found in appendix A).

### 3.2.5 Statistical Procedure

For data analysis the Statistical Package for the Social Sciences 19 (SPSS) was used.

A Pearson correlation was done between the outcomes in order to explore relationships.

Hierarchical linear regression analyses were done in order to examine the predictive power of the reflective, impulsive and executive function measures regressing to: 1) food choice, as well as 2) healthy eating and 3) unhealthy eating. Each of the three behaviours were regressed onto step: 1) reflective (Intention and PBC); step 2) impulsive (temptation and prototypes); step 3) executive function measures (inhibitory control). Finally, in step 4) the interaction of executive function with each of the measures of the reflective and impulsive system was added to the models (moderation effects). All variables included in the interaction term were centred (i.e., individual scale score subtracted by the sample means) in order to circumvent potential problems with multicollinearity (Frazier, Tix, & Barron, 2004). Additionally, the

regression prediction of the food choice was controlled for hunger (step 0). The regression analyses to predict health and unhealthy eating only used the corresponding reflective and impulsive measures.

### 3.2.6 Results

Food choice presented a low correlation with healthy eating ($R$ = .23; $p$ < .001) and no significant association with unhealthy eating ($R$ = -.02; $p$ = .712). Both food intake measures were not significantly associated ($R$ = .08; $p$ = .164).

***Predicting Food Choice:***

Hunger accounted for 3.1% ($p$=.002) of the variance of food choice (step 0; Table 3.2-2). By adding reflective measures the model improved 15.0% ($p$ < .001) with both intentions to eat unhealthy and healthy food, as well PBC over eating healthy food as significant predictors (step 1). By adding the impulsive predictors (step 2) an additional 12.3% ($p$ < .001) of the variance on food choice was accounted for, with PBC over eating healthy food and temptation to eat both type of food as significant predictors. In the third step, inhibitory control accounted for an additional 1.5% ($p$ = .012) of the variance on food choice, over and above reflective and impulsive measures. Finally, the interaction terms between inhibitory control and the other predictors did not add significantly to the variance of the food choice accounted for ($p$ = .214). There was some evidence that inhibitory control moderated the relationship between temptation to eat unhealthy food and food choice, Figure 3.2-4. The interaction suggests that inhibitory control is only related to healthy food choice at lower levels of temptation to eat unhealthy food. In the final model only temptation (both for unhealthy and healthy food) and inhibitory control by temptation interaction emerge as significant predictors. The model accounted for 35.1% for the variance (adjusted $R^2$ = 29.9%).

**Table 3.2-2 – Linear regression predicting food choice from reflective, impulsive and executive control variables**

| | Beta 0 | Beta 1 | Beta 2 | Beta 3 | Beta 4 |
|---|---|---|---|---|---|
| **Step 0** | | | | | |
| Hunger | **-.18**** | -.10 | -.05 | -.05 | -.05 |
| **Step 1** | | | | | |
| Intention (H) | | **.21**** | .11 | .10 | .11 |
| Intention (UH) | | **-.18**** | -.09 | -.08 | -.06 |
| PBC (H) | | **.14*** | **.13*** | .12 | .11 |
| PBC (UH) | | -.10 | -.02 | -.03 | -.03 |
| **Step 2** | | | | | |
| Temptation (H) | | | **.31***** | **.32***** | **.32***** |
| Temptation (UH) | | | **-.35***** | **-.34***** | **-.35***** |
| Prototype Evaluation (H) | | | -.03 | -.04 | -.05 |
| Prototype Evaluation (UH) | | | -.08 | -.07 | -.06 |
| Prototype Similarity (H) | | | -.01 | -.01 | .01 |
| Prototype Similarity (UH) | | | -.00 | .00 | -.02 |
| **Step 3** | | | | | |
| Inhibitory control | | | | **.13**** | .10 |
| **Step 4** | | | | | |
| Inhibitory x intention (H) | | | | | -.10 |
| Inhibitory x intention (UH) | | | | | .05 |
| Inhibitory x PBC (H) | | | | | -.00 |
| Inhibitory x PBC (UH) | | | | | .03 |
| Inhibitory x Temptation (H) | | | | | .10 |
| Inhibitory x Temptation (UH) | | | | | **.14*** |
| Inhibitory x Prot. Evaluation (H) | | | | | .00 |
| Inhibitory x Prot. Evaluation (UH) | | | | | .07 |
| Inhibitory x Prot. Similarity (H) | | | | | .02 |
| Inhibitory x Prot. Similarity (UH) | | | | | .10 |
| **$\Delta R^2$** | **.03**** | **.15***** | **.12***** | **.02*** | .03 |

*Note: H= healthy food; UH= unhealthy food; PBC = Perceived behavioural Control; Prot. = prototype. Adjusted $R^2$ in the final model = .299; *p<.05; **p<.01; ***p<.001.*

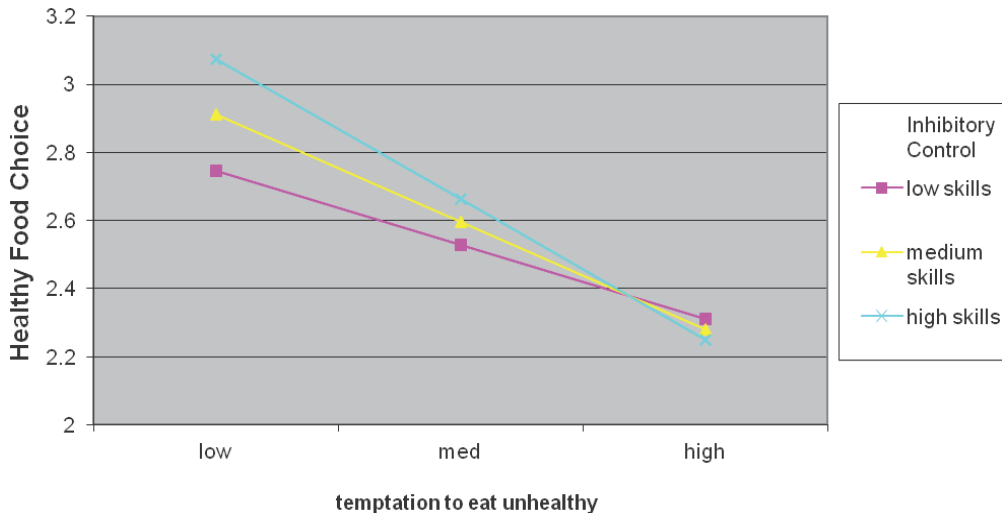


**Figure 3.2-4 – Moderation Effect of Inhibitory Control on Healthy Food Choice by temptation to eat unhealthy food.**

### *Predicting food intake: healthy eating*

Reflective predictors accounted for 4% ($p$ = .005) of the variance in healthy eating (Table 3.2-3). Intention to eat was the only significant predictor. The impulsive measures added in the second step did not significantly improve the model ($p$ = .583). Adding inhibitory control in step three accounted for an additional 3.0% of the variance ($p$ = .004) showing that adolescents with more inhibitory control skills tended to eat more healthy food. Finally, the last step including the interaction terms did not change the variance explained. Only inhibitory control significantly contributed to the prediction in the final model, which accounted for 8.6% of variability (adjusted $R^2$ = 4.6%).

**Table 3.2-3 – Linear regression of healthy eating (24h recall) onto reflective, impulsive and inhibitory control variables**

| Measures | Beta 1 | Beta 2 | Beta 3 | Beta 4 |
|---|---|---|---|---|
| **Step 1** | | | | |
| Intention | **.14*** | .10 | .07 | .06 |
| PBC | .09 | .07 | .06 | .05 |
| **Step 2** | | | | |
| Temptation | | .06 | .08 | .09 |
| Prot. Evaluation | | .03 | .01 | .02 |
| Prot. Similarity | | .05 | .05 | .06 |
| **Step 3** | | | | |
| Inhibitory Control | | | **.18**** | **.16*** |
| **Step 4** | | | | |
| Inhibitory x intention | | | | -.01 |
| Inhibitory x PBC | | | | -.07 |
| Inhibitory x Temptation | | | | -.05 |
| Inhibitory x Prot. Evaluation | | | | -.02 |
| Inhibitory x Prot. Similarity | | | | .03 |
| **$\Delta R^2$** | **.04**** | .01 | **.03**** | .01 |

*Note: PBC = Perceived behavioural Control; Prot. = Prototype. Adjusted $R^2$ in the final model = .046; *p<.05; **p<.01.*

### *Predicting food intake: unhealthy eating*

Reflective measures accounted for 4.1% of variability in unhealthy eating (*p*=.004) with only PBC significantly contributing to the prediction (step 1; Table 3.2-4). Adding impulsive measures did not change the variance accounted for (*p*=.372) whereas adding inhibitory control (step 3) improved the variance explained by 1.5% (*p*=.041). As in the previous analyses predicting healthy eating, adolescents with more inhibitory control skills consumed *more* unhealthy food. The step 4 did not account for additional explanation of the variance in the unhealthy eating (*p*=.513). The final model only accounted for an adjusted 4.3% of variability in unhealthy eating with none of the variables showing significant relationships.

**Table 3.2-4 – Linear regression of unhealthy eating (24h recall) onto reflective, impulsive and executive control variables**

| Measures | Beta 1 | Beta 2 | Beta 3 | Beta 4 |
|---|---|---|---|---|
| **Step 1** | | | | |
| Intention | .05 | .01 | .02 | .02 |
| PBC | **.17*** | **.15*** | .13 | .14 |
| **Step 2** | | | | |
| Temptation | | .05 | .06 | .06 |
| Prot. Evaluation | | -.01 | .00 | .01 |
| Prot. Similarity | | .10 | .11 | .09 |
| **Step 3** | | | | |
| Inhibitory Control | | | **.13*** | .12 |
| **Step 4** | | | | |
| Inhibitory x intention | | | | .01 |
| Inhibitory x PBC | | | | -.11 |
| Inhibitory x Temptation | | | | -.00 |
| Inhibitory x Prot. Evaluation | | | | .08 |
| Inhibitory x Prot. Similarity | | | | .08 |
| $\Delta R^2$ | **.04**** | .01 | **.02*** | .02 |

*Note: PBC = Perceived behavioural Control; Prot. = Prototype. Adjusted $R^2$ in the final model=.043; *p<.05; **p<.01; ***p<.001.*

### 3.2.7 Discussion

The aim of this chapter was to test the relationships between three eating behaviours (food choice and food intake: healthy and unhealthy eating) and predictors derived from dual-process theories of health behaviour. Results showed that when only considering intention and PBC in step 1 of the three main regression analyses, these significantly predict all three behavioural outcomes. However, in the final models the relative role of reflective, impulsive and executive function predictors differs notably.

For food choice, only temptation, an impulsive measure, emerged as a significant predictor. Further, a significant interaction between inhibitory control and temptation to eat unhealthily (food choice task) was found. That is, inhibitory control skills led to a higher amount of

healthy food chosen. Perugini (2005) suggests that impulsive factors are strongly related to spontaneous choices whilst reflective factors strongly influence deliberative behaviour. Friese and colleagues (2006) tested the impact of implicit and explicit attitudes on decisions to buy branded versus generic products. This study included two different experimental groups: one under time pressure to make the decision and the other without time pressure. Results revealed that, when the explicit (from the reflective system) and implicit (from the impulsive system) attitudes diverged, 90% of the participants of the group with no time pressure made a choice aligned with their explicit (reflective) attitude comparing with only 38% of the participants under time pressure. However, in the current study, food intake (healthy and unhealthy eating), neither reflective nor impulsive variables showed significant predictive relationships in the final model. In the regression of healthy eating onto predictors, only inhibitory control demonstrated significant predictive utility, whereas none of the variables was predictive of unhealthy eating in the final model.

Food intake was worse explained by theory-based predictors in comparison to food choice. Some possible explanations may be hypothesised to explain the very low variance explained in food intake. Food may not be under the complete control of adolescents but rather under parental and schools control (if provided with school meals) and consequently individual predictors may be less relevant. Due to the procedural complexities of such a cohort study food intake was assessed 1 to 6 months before the sub-study exploring reflective, impulsive predictors and food choice. It is known that the further away the predictors are assessed in time the poorer the predictions (Jaccard, 2012). Additionally, some of the measures might be more variable over time and context. For example, social cognitions, such as intentions, were shown to be reasonably stable over time (Araújo-Soares et al., in press.; Rhodes et al., 2006), whereas temptation to eat certain food might be more variable and dependent on contextual factors. Jaccard (2012) suggests that assessing people's decisions (and its determinants) several days,

weeks or months before the real context where to make the decision emerges tends to reveal weaker predictive effect since it does not take into account the “split-second” decision. That is, a specific situation might interfere on the decision that was beforehand made, since some cognitive (e.g. interpretation of the context, expectations, etc.) and affective (e.g. feelings, emotions etc.) components might be present in this context that were not anticipated before. In sum, some cognitions are more stable, mostly from past experience and education (E.g. “I need to eat fruits and vegetables to be healthier”) and others are more situation-specific (e.g. “this burger looks amazing”) which will influence the decision (Jaccard, 2012). Previous research assessing the impulsively driven behaviours often uses paradigms where behaviour is assessed immediately after measuring the predictors (e.g. Cervellon, Dubé, & Knäuper, 2007; M Friese, Hofmann, & Wänke, 2008; Perugini, 2005) and the stability of the impulsive processes predicting eating behaviours over time remains unknown.

Situational or dispositional boundary conditions affect the reflective and impulsive system (Hofmann, Friese, & Strack, 2009). However, little is known about how executive function influences these reflective and impulsive processes when their influence is studied together. The current results showed an interaction effect between inhibitory control and temptation to eat unhealthily on the food choice task, showing that more inhibitory control skills led to a higher amount of healthy food chosen. In the final model of healthy eating, inhibitory control was the only significant predictor. That is, better skills to inhibit responses were associated with higher intake of healthy food. Finally, inhibitory control did not predict the unhealthy eating in the final model. It is difficult to compare the present results with those from previous studies. In fact, past evidence has shown that executive control moderates the intention-behaviour gap (Allan et al., 2010, 2011; Hall et al., 2008). However, none of the previous studies included measures from both reflective and impulsive systems, which makes the interpretation on which of the systems

prevails unclear. Furthermore, executive functions are developed throughout childhood and adolescence, and adolescents tend to show lower skills when comparing with adults (Anderson, 2002). Previous research has been focusing on adults, and I am not aware of any similar study conducted in young people.

The current results did not show a significant influence of eater prototypes on any of the eating behaviours investigated (food choice and food intake). In contrast, Gerrits et al. (2010, 2009) showed that the identification with an unhealthy eater prototype was related to unhealthy eating. Dohnke, Steinhilber, & Fuchs (2015) explored the role of prototypes and other social cognitions on eating behaviours, assessed via a food frequency questionnaire, and observational records of healthy and unhealthy eating in a peer context. They found that adolescents that were more favourable to healthy eater prototypes showed healthier intake. However, in the peer context, the relationship between prototypes and the intake of healthy and unhealthy food was not significant. Taking this evidence into account, it remains unclear if the assessment of food intake, in the current chapter, would have been made at the same time when the prototypes were assessed, similar results to those reported by Dohnke, Steinhilber, & Fuchs (2015) would have been found. With the available evidence it seems that in a food choice context, prototypes are not an important factor to make a choice (Dohnke et al., 2015).

Overall, the results of the present chapter challenge the assumption of the traditional theories showing that reflective measures might not be enough to predict behaviours, but impulsive processes (for food choice) and executive function (for food intake) seem to be promising but more replications are needed to better understand these relationships, particularly in young people.

### *Strengths and Limitations*

Some limitations need to be considered when interpreting the results in this chapter. Firstly, a limited amount of food was included in the eating behaviours. However, the foods selected were the most frequently eaten snacks by adolescents in the same age range (Adamson et al., 2011). Food choice was assessed in a laboratory context which may have influenced the choices made by feeling some social pressure with the presence of the researcher in the same room. To overcome these limitations the researcher explained to the adolescent that there was no right or wrong choices, that (s)he could choose the favourite food and no positive or negative feedback was given on the choices across the experiment. Finally, the PBC measures showed a low Cronbach alpha, nevertheless it was decided to keep this measure in the analyses, since it has been widely used in the literature and identified as predictive of behaviour even during adolescence (e.g. Hewitt & Stephens, 2008). It remains unclear if this affected the non-significant relationship between PBC over unhealthy eating and food choice.

Despite these limitations, the results bring some new findings on the role of impulsive and executive function on food choice. To my best knowledge, no studies integrated together the reflective, impulsive and executive control and exploring their influence on eating behaviours in adolescents. Indeed most of the studies exploring dual-process models are focused on adults and tend to assess only one of type of behaviours with the exception of studies that target predictive effects of prototypes that focus on both reflective and impulsive variables and often target both healthy and unhealthy eating as considered in this chapter.

### *Future Research and practical implications*

At this stage, more exploratory research in this area is needed in order to allow for replication to confirm these results and gain consensus, before using the results found in the present chapter to

design intervention to increase healthy eating behaviours. Longitudinal studies may provide important information about the stability of the predictors (particularly impulsive measures) over time. Integrating reflective, impulsive and executive function may be useful to better understand complexity of eating behaviour and help future interventions on adolescents' eating behaviours.

# Chapter 3.3 Food choice in adolescence: direct, indirect and interaction effects of individual, social and environmental predictors.

### 3.3.1 Abstract

*Background:* People are everyday confronted with several food choices. Evidence has shown that these choices can be influenced by individual, social and environmental factors. The present chapter aimed to explore how these factors are linked with each other and understand their role on food choice in a sample of adolescents aged 12-13 years.

Methods: 285 adolescents completed a questionnaire measuring: reflective [intention and perceived behavioural control (PBC) over eating (un)healthy foods]; impulsive [(un)healthy eater prototypes and temptation to eat (un)healthy foods] and home environment measures. Adolescents also completed a Stop-Signal Task in order to assess inhibitory control skills (executive function). Food choice was assessed using a series of face-to-face Behavioural Choice Tasks measuring the propensity to choose healthy/unhealthy foods. Level of deprivation and weight status were also collected. Data were analysed using linear regression and path analysis.

*Results:* Executive function, reflective and impulsive processes had a direct effect on food choice, with temptation as the most important predictor. Home environment and BMI was associated with the food choice indirectly via temptation and intention to eat. Level of deprivation and prototypes did not have any statistically significant pathways in the final model. Inhibitory control moderated the intention-behaviour gap relationship.

*Conclusions:* Temptation to eat seems to have a stronger influence on an immediate food choice task. Furthermore, the intention-behaviour gap seems to be reduced by the inhibitory control but only when considering the choice of unhealthy foods. Results of the current chapter suggest that adolescents may benefit from interventions targeting inhibitory control skills, as well as, home environment that can influence temptation and intention to eat in order to promote healthier food choices.

### 3.3.2 Introduction

In a world with an abundance of food, people are continuously confronted with the temptation of the immediate reward value of palatable and high-caloric food (Bos, Ridder, Van den Bos, & De Ridder, 2006; Verbeken, Braet, Claus, Nederkoorn, & Oosterlaan, 2009) which have a negative impact on the quality of their dietary intake (Wardle, 2007). Over the past decades, the prevalence and frequency of snacking have not only increased among children and adolescents, but snacking has also become more energy-dense and nutrient-poor (Larson & Story, 2013; Piernas & Popkin, 2010). Given the growing contribution of food that can be eaten as snacks to dietary intake, it is essential to understand how people make their choices when pondering between this healthy and unhealthy food in order to build future effective prevention programmes that can gain from this knowledge. This is particularly important in adolescence, since they experience increasing levels of autonomy in food choice, they are confronted to larger range of options (Cohen, Brownell, & Felix, 1990) and they start having the resources to purchase food (Darling et al., 2006; Farrell & Shields, 2007; Stok et al., 2010).

It is known that individual, social and environmental factors influence eating behaviours (Sallis et al., 2008). In the previous chapter, we tested a dual-process approach by exploring the influence of individual and social factors on eating behaviours. Strack and Deutsch (Strack & Deutsch, 2004) propose that behaviour is influenced by two systems: a reflective and an impulsive system. The former is a slow process, deliberative, that requires high cognitive capacity, the latter, is fast, reflexive, does not require high cognitive capacity and it is triggered by impulses. In adolescence, the prototype willingness model – a dual-process model (Gibbons & Gerrard, 1995) has been applied but very few studies targeted eating behaviours. This model postulates that behaviour is influenced by social comparison via a prototype i.e. a person behaving in a specific way with similar age of the participants. Research using this model

and targeting eating behaviours has revealed that adolescents have positive images of healthy eaters and negative images of unhealthy eaters, but only the identification with an unhealthy eater prototype predicted unhealthy eating practices (Gerrits et al., 2010, 2009).

According to these distinct approaches people have different responses when confronted with the same situation. Some people are able to resist contextual cues but for others it seems impossible. Some research has focused on studying this ability to resist by exploring the role of the executive function (e.g. Allan et al., 2011; Hall et al., 2008; Hofmann, Friese, & Roefs, 2009). One of the core features of executive function are inhibitory control skills which determine the ability to controlling attention, behaviours or thoughts (Diamond, 2013). Some evidence has shown that lower inhibitory control skills have been associated with unhealthier eating behaviours and higher body mass index (BMI) in adults (Allan et al., 2008, 2010; Nederkoorn et al., 2006). It may also influence behaviour indirectly by interacting with the reflective and impulsive systems (Allan et al., 2011; Hall et al., 2008; Hofmann, Friese, & Roefs, 2009; Honkanen et al., 2012).

Despite the importance of studying individual and social factors using a dual-process approach, environmental factors, that have also been identified as a key to better understand eating behaviours in adolescence, are not specifically targeted. In a world where availability of food seems to not be a problem, resisting temptation, from the environment, becomes a real challenge. Some studies in adolescents have found that availability of food at home seems to be an important environmental factor for food intake (Haerens et al., 2008; Neumark-Sztainer et al., 2003). For instance, Neumark-Sztainer et al. (2003) conducted a cross sectional study with a sample of 3957 adolescents with an average age of 15 years. In this study, several predictors of FV intake were assessed: food preferences, attitudes, social support, family meal patterns, food security, socio-economic status, and home availability of FV. Results

revealed that home environment was the strongest predictor that mediated the relationship between FV intake and all the other variables (with the exception of preferences). These results highlighted the importance of home environment, however, to date little is known on how environment is related to individual and social factors integrated in a dual-process model in adolescents. This would be helpful to better understand the complexity of eating behaviours and the interrelationships between variables.

Intra-individual factors may also influence eating behaviours. For instance, weight status has been more widely studied in association to food intake. However, results remain inconsistent. For example, in a review by Larson and Story (2013), thirteen studies did not find any association between these two factors, eight found a negative relationship and nine studies found that frequency of snacking and the energy from snacks was associated with higher risks for obesity. Nevertheless, the review did not analyse the possible contribution of the type of snack on obesity. In the present chapter, the relationship between BMI and the choice made between healthy and unhealthy snacks will be analysed.

Social factors such as deprivation has been also associated with food intake (Caireen, 2014; Currie et al., 2012). Living in a deprived area, does not only have a negative influence on fruit and vegetables consumption, but seems to also be positively associated with unhealthy (high sugar, high fat) food intake (Craig et al., 2010; Darmon & Drewnowski, 2008; van Sluijs et al., 2008; Wardle, Jarvis, et al., 2003).

### 3.3.3 Aims

Although the above-mentioned factors regarding food intake have been studied previously, little is known of their influence on a choice between healthy and unhealthy food. Furthermore, to my best knowledge, no efforts have been made to explore how the different factors influence each other to predict a food choice in a global

approach, i.e. integrating multilevel predictors inter-relating (individual, social and environmental). Therefore, in addition to the previous chapter (that included reflective and impulsive predictors as well as executive function predictors based on a dual-process model) the current chapter will integrate availability of food at home, BMI, and level of deprivation and their relationships to explain the food choice in a sample of adolescents aged 12–13 years.

### 3.3.4 Methods

#### *Participants and Procedures*

The ethical approval from Newcastle University Research Ethics Committee (00510/2011 and 00523/2012_2) was received in May 2012. The present research analysed a sub-sample of the Gateshead Millennium study (GMS; Parkinson, Pearce, et al., 2011), a British birth cohort study following 1029 children born in 1999/2000. The GMS collected information on the first year of life, during childhood and adolescence in several waves (15 altogether).

This chapter used data collected by the GMS in 2012 (15$^{th}$ wave), when participants were aged 11-13, which consisted of three face to face assessments. The first two assessments were part of the standard assessment procedures of the GMS where food intake was assessed by a 24h recall (INTAKE24, Foster et al., 2014). During the standard consent procedures, parents and adolescents were invited to take part to an optional food choice sub-study. Between August 2012 and March 2013, those parents who had consented (n=367) were contacted. After providing full information about a food choice sub-study, a total of 303 (82.56%) parents/adolescents consented/assented to participate in the sub-study which took place one to six months after the second visit of wave 15. Of the 303 participants, only 274 were assessed on food intake at the standard assessment procedures of the GMS (mostly due to the absence of the participants at school during data collection).

In order to offer families the option of data collection on school premises, collaborating GMS schools were contacted. Eight of the nine schools agreed to participate. Overall, 64% of participants were assessed in their schools, 35% were assessed at home and 1% was assessed at Newcastle University. There were no statistically significant differences between the main characteristics of the GMS sample of answering the 15$^{th}$ wave (n= 525) and the sample reported on in this chapter regarding age ($p$=.13), weight status ($p$=.69) and sex ($p$=.90) and deprivation level ($p$=.91).

### *Measures*

Level of deprivation: postcodes of participants and their families were collected. The postcodes were converted to the IMD 2007 using the UK data service census support website (http://geoconvert.mimas.ac.uk/). IMD measures deprivation levels in England based on the geography Lower layer Super Output Area (LSOA) where the most deprived LSOA for each Index is given a rank of 1 and the least deprived LSOA is given a rank of 32,482 (Noble et al., 2007). For the purpose of the present chapter, the IMD ranks were divided in quartiles by dividing the British ranks into quarters and allocating each GMS participant to the respective quartile according to IMD rank. More deprived areas are represented in the lower quartiles and higher quartiles represent less deprived areas.

Weight status: Height was measured to 0.1 cm with a Leicester Portable height measure and weight measured to 0.1 kg with a TANITA TBF 300MA. Body mass index (BMI) was calculated and classified as obese, overweight or healthy weight according with the IOTF growth chart cut-offs – called BMI z-scores – which takes into account the age, sex, height and weight of the participant (Cole et al., 2000). Two participants did not assent to being measured.

*Reflective measures*

Three items each were used to assess *intention* to eat healthy (e.g. I intend to eat fruits and/or vegetables as snacks, between main meals; $\alpha$ = .71) and unhealthy foods (e.g. I intend to eat sweet/savoury snacks, between main meals; $\alpha$ = .71). *Perceived Behavioural Control* (PBC) was assessed with three items for healthy food (e.g. If I wanted to I could eat fruits and/or vegetables as snacks, between main meals; $\alpha$ = .51) and two items for unhealthy foods (e.g. If I wanted to I could eat sweet/savoury snacks, between main meals; $\alpha$ = .63). The intention and PBC items were based on standard assessment procedures (based on Ajzen, 2002) and responses were given on a five point scale (from 1 = definitely true to 5 = definitely not true) and scaled as the average response across items (separately for healthy and unhealthy). Higher scores indicated higher level of intention and PBC.

*Impulsive Measures*

*Temptation:* Fifteen healthy foods and 15 unhealthy food that can be eaten as snacks that were mostly eaten by children aged 11-12 in the North East of England (Adamson et al., 2011)[6] were selected to be used within the impulsive measures – Table 3.3-1 – and a picture of each food was produced (see appendix F) to assess *temptation.* Participants were asked to evaluate 15 healthy ($\alpha$ = .84) and 15 unhealthy foods ($\alpha$ = .87) according to the level of temptation attributed to the food represented in the image: "To me, [food illustrated on the screen] is a temptation, difficult to resist eating"; 1 = strongly disagree; 5 = strongly agree (based on Kroese et al., 2011). Scales for statistical analysis were computed using the average of the items (separately for temptation to eat healthy and unhealthy food). Higher scores indicated higher level of temptation.

[6] Participants in the Adamson et al., 2011 study were very similar to the study in the current chapter and did not differ regarding sex ($p$=.43) and BMI ($p$=.06). However, the sample of the present study lived in more deprived areas ($p$<.001).

**Table 3.3-1 – Food selected for measuring temptation.**

| Healthy | Unhealthy |
|---|---|
| Apple | Boiled sweets |
| Banana | Crisps |
| Carrot | Flapjack |
| Kiwi | Chocolate cake |
| Orange | Chocolate biscuits |
| Grape | Sausage roll |
| Pear | Pizza |
| Cherry | Chips |
| Strawberry | Digestive biscuits |
| Tomato | Jellies |
| Cucumber | Crispy cake |
| Raisins | Coco pops |
| Pineapple | Potato waffle |
| Peach | Chocolate |
| Melon | Cereal bar |

*Prototypes:* Two prototypical images of 1) adolescents who frequently eat healthy and 2) adolescents who frequently eat unhealthy snacks were assessed based on recommendations by Gibbons and Gerrard (1995). *Prototypes evaluation* was assessed by asking the participants to give their opinion about healthy prototypes (e.g. what's your opinion about the type of person of your age who eats fruits and/or vegetables as snacks between main meals?) and unhealthy prototypes (e.g. what's your opinion about the type of person of your age who eats sweet/savoury snacks between main meals?). The answer was given by the 'evaluation thermometer' on a 0-100% scale (0% do not approve at all and 100% completely approve). Higher scores indicated a favourable opinion about the prototype. *Prototype similarity* was assessed by asking the participants to report how similar they felt to each prototype on a five point scale (e.g. for the healthy prototype: 'In general, how similar are you to the type of person your age who eats fruits and/or vegetables as snacks between main meals?' 1= not at all similar to 5= very similar). The same item was developed for the unhealthy prototype.

Higher scores indicated that adolescents felt more similar to the prototype assessed.

*Executive Function measure*

Inhibitory Control was assessed using the stop-signal paradigm in the Inquisit software©, on a 13.3" screen laptop. This involved two concurrent tasks: a go-task and a stop-task (Verbruggen et al., 2008). During the go-trials participants were instructed to discriminate whether an arrow was pointing to the left or to the right, pressing the "D" (left) or "K" (right) key on the keyboard as fast as possible depending on the direction of the stimulus (the arrow). In turn, the stop-trials involved the presentation of an auditory signal that indicated to participants to inhibit their response to the arrow (Figure 3.3-1).

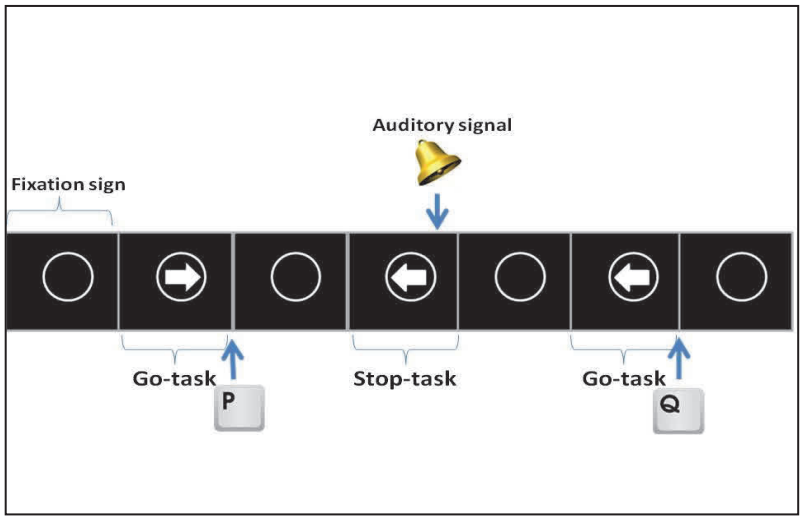


**Figure 3.3-1 – Stop-Signal Task procedure**

Each participant completed one practice block of 32 practice trials followed by 3 blocks of 64 actual trials each which included 25% of stop-trials. All blocks started with a fixation sign which remained for 250 ms, subsequently the stimulus (i.e. the arrow) appeared until the participant responded or until 1250 ms had passed. An interval of 2000 ms was included between the stimulus and of 10 seconds between blocks.

Reaction time to respond to the stimulus was recorded. The stop-signal was presented in a variable stop signal delay (SSD), i.e. the

delay between the go-task stimulus (arrow) and the stop signal (auditory signal). At first, the SSD occurred at 250 ms and was adjusted continuously according to the performance of the participant: when the inhibition was successful the SSD increased by 50 ms, however, when the inhibition failed the SSD decreased by 50 ms. Also, the software estimated a stop-signal reaction time (SSRT) by subtracting mean SSD from the mean reaction time (Logan et al., 1997). SSRT is the most important variable of this task, and was inverted for a better understanding of the results. That is, lower scores indicating less inhibitory control skills. Five participants were excluded due to hardware problems.

*Environmental measures:*

*Availability of food at home*: was assessed by asking the participants to rate the availability of healthy (How often do you have fruits and/or vegetables as snack at home?) and unhealthy food (How often do you have sweet/savoury snacks at home?) at home (adapted from Neumark-Sztainer et al., 2003) and the access to both types of food that parents gave them (How often do your parents give you fruits and/or vegetables to eat as a snack between main meals? And same question for unhealthy food). Therefore, this variable included 2 items ($\alpha$ = .64 for both type of food) for each type of food and ratings were given on a five points scale, from never (1) to always (5). Higher scores reveal more availability of food at home.

*Outcome:*

*Food choice:* The Behavioural Choice Task © (Lappalainen & Epstein, 1990) was used to assess food choice. Before task was initiated participants were asked: "At this moment, how hungry are you?"; scaled 1 = not at all to 5 = very much (Piech et al., 2010). This allowed controlling hunger in the statistical analysis and guarantying that the choice was not influenced by hunger. To conduct the task a selection of 8 food images with good availability across seasons for each type of food (from the 15 healthy and unhealthy foods selected for assessing temptation – Table 3.3-1 – Adamson et al., 2011) was

used. The healthy food options were 1) apple, 2) banana, 3) carrot, 4) kiwi, 5) orange, 6) grape, 7) pear, 8) cucumber and the unhealthy food options were 1) boiled sweets, 2) crisps, 3) flapjacks, 4) chocolate biscuits, 5) jellies, 6) crispy cake, 7) coco pops, 8) chocolate. Before the task, portions of each food were shown to make sure that participants understood the type and size of each reward. Participants had the chance to choose between both types of food before each of the trials. The task consists of two sets of three boxes in which different shapes and colours rotate every time the mouse button is pressed (like a slot machine) – Figure 3.3-2. The participant gets one point every time the shapes match in colour and shape. It was also explained that 15 points (each trial) earned would be exchanged for 1 portion of a chosen food. The task included 5 trials.

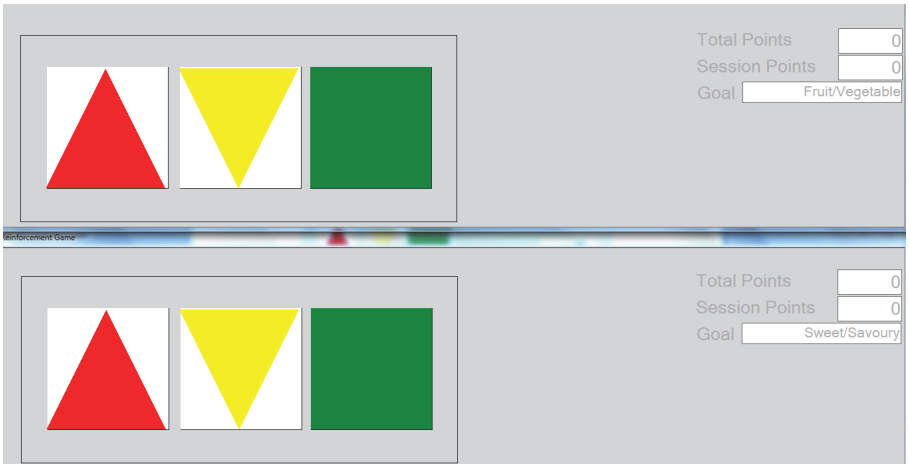


**Figure 3.3-2 – Behavioural Choice Task**

The task began with a concurrent schedule VR2/VR2 (the participants got on average one point every 2 responses for both schedules, i.e. for either choice: healthy or unhealthy food), after this, schedules doubled across the four subsequent trials from VR4 to VR32 for the reinforcer (i.e. healthy or unhealthy) chosen and consequently behavioural costs increased. However, the schedule remained the same when the reinforcer was not chosen. Therefore, the adolescents chose those foods that more motivated them to work on the task.

This task allowed calculating the amount of each type food chosen; scale ranging from 0 to 5 portions. Because the total amount of food after the task (5 trials) can only be 5 portions, if the amount of healthy food portions is known, (e.g. 3 portions of the healthy option achieved by the end of the task) then the amount of unhealthy portion of food can easily be calculated (2 portions of unhealthy portions). For this reason, only data from healthy food will be reported from here on for this specific variable (food choice).

### 3.3.5 Statistical Procedure

Relationships between the adolescent's food choice and explanatory measures were explored in the previous chapter through an adjusted theory-based model including hunger, reflective, impulsive and executive function predictors.

To estimate indirect pathways (i.e. predictors of adolescents' food choice which are mediated through other variables), the adjusted model was reconstructed as a path diagram. Measures that were not significant in the adjusted model (i.e. that were not predictive of adolescent's food choice) were then added to the path diagram, and all paths or correlations with $p < .05$ were modelled. Availability of food, deprivation level and BMI z-scores were then added to the model.

When interactions between inhibitory control and reflective/impulsive processes on food choice were tested, the respective variables were centred in order to circumvent potential problems with multicollinearity (Frazier et al., 2004).

Model fit was assessed using model chi-square, comparative fit index (CFI), root mean square error approximate (RMSEA) and standardized root mean square residual (SRMR). Adequate fit was defined as chi-square *p*-value over .05, CFI over .95, RMSEA below .07 and SRMR below .08, GFI over .95 (Hooper et al., 2008).

Participants with missing data in any measure included in the model were excluded.

Standardised beta coefficients (β) were derived for each explanatory variable in order to allow comparing and estimating the relative importance of each measure (i.e. a standardised coefficient is the SD change in adolescent's food choice elicited by a 1 SD change in the explanatory measure), except for the interaction terms where the unstandardised coefficient will be described as recommended by Frazier, Tix and Barron (2004).

All standard statistical analyses were done using the Statistical Package for the Social Sciences 19 (SPSS) while path analyses were done in AMOS 17.0 (SPSS Inc, Chicago, IL).

### 3.3.6 Results

Nineteen models were tested step by step in order to get to the final model (see appendix H). This last is represented in the Figure 3.3-3 where the standardised direct effect of each significant relationship is presented, as well as the standardised total effect of each variable (i.e., including both the direct effect and indirect effects mediated through other variables). The overall model explained 31% of the variation in food choice and presented a good fit.

***Direct effects:***

Five variables directly predicted food choice: Inhibitory control (β = .14; $p$ = .007), intention to eat unhealthy food (β = -14; $p$ = .008), temptation to eat unhealthy food (β = -.40; $p$ < .001), PBC over eating healthy food (β = .10; $p$ = .042) and temptation to eat healthy food (β = .36; $p$ < .001)

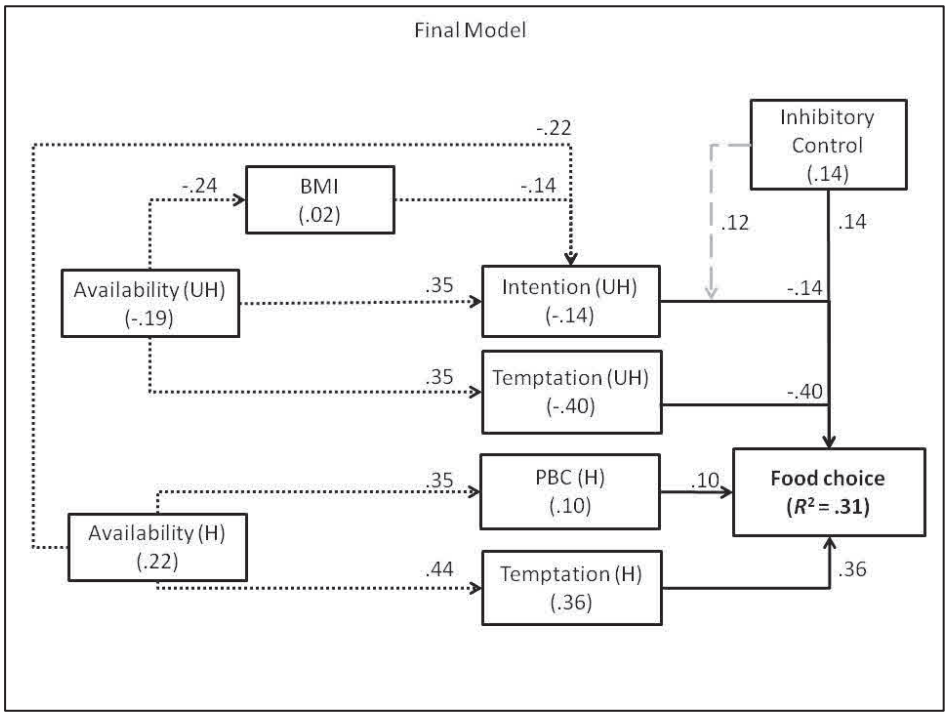


**Figure 3.3-3 - Path diagram showing direct and indirect predictors of the adolescents' food choice.**

*Note:The final model only presents significant effects (p<.05) which are represented by arrows. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients (β) are shown above each arrow (except for the interaction effect where the unstandardised coefficient is shown). The black dashed arrows represent indirect effects, i.e. the pathways mediated through at least one intermediate predictor (e.g. Availability -> Temptation -> food choice). The grey dashed arrows represent the interaction effects (e.g. Intention x Inhibitory control -> food choice). In contrast, the solid arrows show the direct effects which are going straight from the independent variable to the food choice. The standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name. Error terms and co-variances are omitted for simplicity. To simplify the figure paths the covariances are not drawn, i.e. temptation to eat healthy food and temptation to eat unhealthy food (p<.001), temptation to eat unhealthy food and intention to eat unhealthy food (p=.008). Model fit: $\chi^2(27) = 37.78$, p = .08, RMSEA = .038 [90%CI = .00, .06], GFI = .98, CFI = .97. N = 285.*

### *Indirect effects and associations between predictors of food choice:*

Availability at home of healthy and unhealthy food did not directly predict food choice. However, both variables were mediated through others. Availability of healthy foods at home significantly predicted the temptation to eat healthy foods (β = .44; $p < .001$), the PBC over eating healthy foods (β = .35; $p < .001$), the intention to eat unhealthy

foods (β = -.22 *p* = .001). Availability of unhealthy foods at home predicted intention to eat unhealthy foods (β = .35; *p* < .001) and temptation to eat unhealthy foods (β = .35; *p* < .001). Availability of unhealthy foods at home also predicted BMI (β = -.24; *p* = .001) and BMI predicted food choice indirectly via intention to eat unhealthy foods (β = -.14; *p* = .007).

### *Covariates*

Temptation to eat healthy food and temptation to eat unhealthy food were positively related (*p*<.001) with each other and temptation to eat unhealthy food was also associated with intention to eat unhealthy food (*p*=.008).

### *Interaction effects:*

In the final model, inhibitory control moderated the relationship between intention to eat unhealthy food and the food choice (B = .10; *p* = .014). Adolescents with worse inhibitory control skills and higher intention to eat unhealthy foods have chosen less healthy foods – see Figure 3.3-4. In contrast, adolescents with better inhibitory control skills tended to chose healthier food even if they intended to eat unhealthy ones. Adolescents with low intentions to eat unhealthy foods tended to choose more healthy foods in the food choice task independently their score in the stop-signal task.

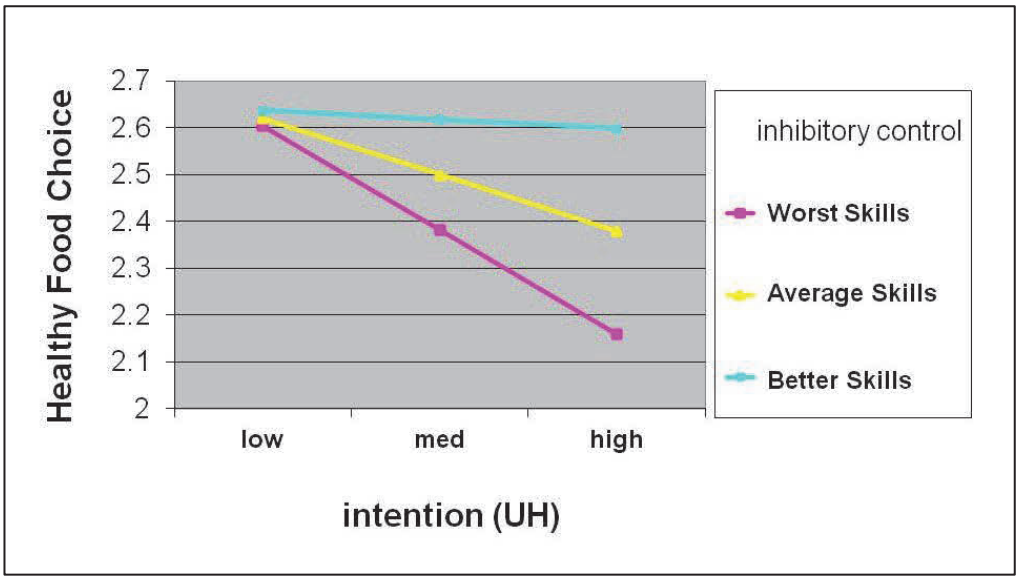


**Figure 3.3-4 - Interaction effect graph between inhibitory control and intention to eat unhealthy food on the healthy food choice**

This interaction result is incongruent with what was reported on Chapter 3.2. Indeed, in the previous chapter, inhibitory control significantly interacted with temptation to eat unhealthily but not with intentions. This may be happening because the models are different. Indeed, the previous chapter tested only factors based on a dual-process approach, i.e. reflective, impulsive and executive factors, whereas in the current chapter home environment, level of deprivation and BMI were also included. Furthermore, in the current chapter, the final model only includes significant associations/paths.

To better understand how inhibitory control interacts with the two systems postulated by the dual-process models (reflective vs. impulsive), two independent regressions were done, including intention (reflective) and temptation (impulsive). Then, both variables were included in a final adjusted regression model.

Results showed that when the interaction terms were included independently in two different regressions, both were not significant. However, when the interaction terms were included in the same regression model (adjusted model), results revealed that inhibitory

control significantly interacted with intentions to eat unhealthily (B=-.11; *p*=.029) but not with temptation.

### 3.3.7 Discussion

The current chapter used a global approach to analyse the role of multilevel factors in predicting food choices. The aim was to investigate the direct and indirect effects of reflective, impulsive, environmental measures, as well as the potential role of BMI and deprivation on healthy and unhealthy food choices. Additionally, the moderating effect of executive function on reflective and impulsive processes was also explored.

Although the reflective measures (intention to eat unhealthily and PBC over eating healthily) significantly influenced the food choice as traditional health behaviour theories suggest (e.g. Ajzen, 1991; Bandura, 1978; Fishbein & Ajzen, 2010), the results revealed that the main determinant of the experimental food choice task was temptation. This might indicate that in a quick decision adolescents are more influenced by their impulsive system of information processing. Similar conclusions were suggested by Perugini (2005) who tested a dual process approach in adults. This author found that people tend to behave according to their implicit preferences with no influence of their explicit preferences in quick choices, whereas in a situation where people have more time to choose, they behave more in accordance with what they explicitly reported rather than their implicit preferences.

It is known that the association between intention and behaviour is weaker among adolescents compared to adults (McEachan et al., 2011). Therefore, the present chapter tested how inhibitory control could influence the intention-behaviour gap. The results showed that better control skills, even when adolescents intended to eat unhealthy foods, influenced the adolescent to make a healthier choice. These findings support the results of previous research on the interaction of executive function on the intention-behaviour gap in

adults (Allan et al., 2008, 2011; Hall et al., 2008). Being able to inhibit behaviour seems to be key to control reflective processes related to intentions to eating unhealthy and consequently make healthier food choices.

Although health behaviour theories focusing on reflective predictors and dual-process approaches have been extremely helpful in explaining food choice, the present results suggest that food choice is also indirectly influenced by the availability of food at home and BMI. This shows that choices are not only made through individual factors but that the environment can also influence choices by influencing its processes. In fact, availability of food at home had an association with both reflective and impulsive processes. That is, adolescents with more availability of unhealthy food at home tend to have higher intentions and feel more tempted to eat unhealthy food than those who reported having less of this type of food at home. Furthermore, adolescents who reported having healthy food at home regularly, also tended to have a higher perception of control over eating healthy food and feel more tempted to eat it than those who rarely have healthy food at home. This indirect influence might explain why previous reviews have found inconsistent results when associating home environment and food intake (McClain et al., 2009). In fact, the studies reviewed might not have found direct effects, but a more global approach to their analyses would have maybe shown paths between both variables. The non-existence of a direct path may also be due to the fact that fruits and vegetables were integrated together in the same food group, as well as sweet and salty/savoury food that were included together. Reinaerts et al. (2007) studied fruits and vegetable consumption separately and found that availability of fruits at home predicted its consumption but vegetable availability did not predict its consumption. This result might have been achieved because vegetables tend to be hidden from sight in the refrigerator whilst fruits tend to be out displayed on the kitchen/dining room top/table. Different food types were included in each of the groups in the present chapter, this might have limited

an observation of the direct effects that availability could have on food choice.

Availability of unhealthy food was found to directly influence BMI. That is, adolescents reporting having this type of food more often at home tended to have lower BMI levels. This result seems unexpected. It seems parents are aware that access to unhealthy food should be limited as a result of identified BMI issues (overweight or obesity). However, this assumption would go against previous reviews that showed that parents were not able to identify their child's weight status correctly, by assuming that their child has a normal weight when in reality s/he was overweight or even obese (Doolen, Alpert, & Miller, 2009; Towns & D'Auria, 2009). In the present cohort, it was found that, at the age of 6-8 years old, 7.3% of children were perceived as 'overweight' or 'very overweight' by their parents when in reality 23.7% were categorised as overweight or obese (Jones et al., 2012; Parkinson, Drewett, et al., 2011). However, data at the age of 12-13 years old about parents' perception of their children weight status was not investigated, neither in this thesis nor by the GMS team.

BMI levels were not directly associated with food choice. However, intention to eat unhealthy food was lower in adolescents with higher BMI. Adolescents might be aware of their weight status and consequently want (explicitly) to decrease unhealthy food intake. But this intention was not enough to translate into action given that BMI did not directly predict the food choice made during the task. Studies between weight status and consumption of eating behaviours, such as fruits, vegetables, and snacks consumption have found inconsistent results (Davis et al., 2007; Spear et al., 2007) which limits the understanding in this area.

In a stage of life commonly associated with the idea that others, particularly friends, are very important, it was surprising to find that prototypes did not have any direct or indirect effect on food choice. Dohnke et al. (2015) explored the impact of the Prototype

Willingness Model (Gibbons & Gerrard, 1995) in two different behaviours: general eating pattern index (self-report) and intake of unhealthy and healthy snacks in a the peer context (behavioural observation). Their study found that prototype was a direct predictor of the general eating pattern index whereas in the peer observational context no association was found between intake and prototypes. One possible explanation for their latter finding and the results found in the present chapter may be due to the type of assessment. In fact, the previous studies in the literature that showed a direct effect of prototypes on eating behaviours mostly used self-reports to assess the outcome (Gerrits et al., 2010, 2009) instead of experimental or observational situations. Another reason could be associated to the fact that the behaviour enquired on the prototype questionnaire used in this thesis was slightly different from the current outcome (food choice). That is, adolescents were asked to assess a person that frequently eats healthy/unhealthy food and not about a person that chooses one or the other type of food (although one can presume that this is implied that people eat more unhealthy food because they choose to do so). Given that the outcome of the present chapter focused on a choice performed between an unhealthy or healthy food this might have limited the emergency of a possible relationship between the assessed prototype and the outcome. In sum, research in this area is very limited and more studies are needed to test the prototype willingness model and different eating behaviours outcomes.

### *Strength and limitations*

The current study is the first, to my best knowledge, that studied determinants of food choice in adolescence using a global approach integrating variables emerging from a dual-process model, executive function, environmental, anthropometric and socioeconomic variables. Therefore, this study used an ecological framework which can guide future interventions in supporting adolescents to make healthier food choices.

However, some limitations need to be considered. This study used a cross-sectional design and so no predictive relationships can be inferred and results need to be interpreted cautiously. Also, the experimental food choice may not completely represent real life choices (ecological validity issues). The advantage of using this type of assessment is that the motivation to choose a specific type of food was controlled for by asking the adolescents to work for their choice. In real life, people have intrinsic motivations to prefer one specific food rather than the other that is manifested in concrete choices of food. While results revealed a number of significant findings, it is also possible that some were missed due to a potential lack of statistical power.

### *Future Research*

Future research should take into account the limitations reported above. More efforts into better mapping and test the relationships explored here are needed in order to improve future interventions targeting food choice. Therefore, targeting inhibitory control skills and temptation to eat more healthily in such eating behaviours programs should be considered. In fact, inhibitory control seems to have a protective effect on intentions to eat unhealthy food which improved the healthy choice made by the adolescents. In its turn, temptation was the strongest predictor of the food choice. Furthermore, giving the opportunity and educating parents to have healthy food available in the house and not unhealthy food may indirectly influence food choices in adolescence through factors from the individual level. These results shows that a global approach focused on individual and environmental aspects would support adolescents to make healthier choices.

# SECTION 4

# FROM CHILDHOOD TO ADOLESCENCE

*Glossary Reminder:*

**Eating behaviours:** Set of behaviours assessed across the thesis and described below:

**Food choice:** This variable was assessed during adolescence via an experimental behavioural food choice task. Adolescents could obtain 5 portions of healthy, unhealthy or a mix of both food (that can be eaten as snacks). The results presented reflect the number of healthy choices made (from 0-5) which are the reverse of the number of unhealthy ones made (pictures of the food included in this task can be found in appendix G).

**Food Intake:** was assessed via a 4 days food diary (FAST) during childhood and via a 24h recall (INTAKE24) during adolescence. Two specific behaviours were analysed across the thesis (detailed list of food included can be found in appendix A):

- **Unhealthy eating:** consumption of sweet/savoury food that can be eaten as snacks (e.g. sweets, chocolate, cake, crisps)
- **Healthy eating:** consumption of fruit and vegetables.

**Predictors:** this term is used in order to facilitate reading. However, it is important to highlight that the analysis in this thesis cannot imply any causality assumption. Only associations between the variables assessed can be established.

# Chapter 4.1 Predicting eating behaviours: from childhood to adolescence.

### 4.1.1 Abstract

*Background:* Several studies demonstrate that food intake tends to track, to some extent, over time, however little is known about what influences this tracking. This chapter investigated tracking of food intake, as well as, the influence of predictors of food intake during childhood on eating behaviours and their predictors in adolescence.

*Methods:* Participants of the Gateshead Millennium Study (n=210) were assessed in childhood (6-8 years) and adolescence (12-13 years). Food intake was measured at both time points and a situational food choice assessment was added in adolescence. Participants answered questions about predictors of eating behaviours adapted to each age group.

*Results:* A moderate tracking of healthy eating was found ($r$ = .21) whereas unhealthy eating presented low tracking ($r$ = .14). Higher BMI during childhood significantly predicted less unhealthy food at home during adolescence and was associated with higher BMI at this developmental stage. Liking fruits in childhood was positively associated with healthy food availability at home and temptation to eat healthy food during adolescence. Higher levels of knowledge about healthy eating in childhood significantly predicted less intention to eat unhealthy food in adolescence. Healthy eating during childhood was associated with lower BMI and positively associated with temptation to eat unhealthy food during adolescence. Children eating more unhealthy foods presented less inhibitory control skills in adolescence. Children preferring healthy food tended to eat less unhealthy food in adolescence. Lower BMI and higher levels of healthy eating in childhood were associated with healthier eating in adolescence.

*Conclusions:* These results highlight the importance of developing interventions promoting healthy eating early in life. Further research in this area exploring such complex associations would help to confirm and gain a consensus on results.

### 4.1.2 Introduction

Fruit and vegetables (FV) are highly recommended in order to prevent non-communicable disease, such as obesity and cardiovascular disease (Boeing et al., 2012; WHO, 2002). Although there has been an increase on the consumption of FV between 2002 and 2010 among adolescents from 33 countries (mainly European and North American), a large proportion of participants reported not eating FV on a daily basis (Vereecken et al., 2015). In contrast, some studies in the U.S. have found that the consumption of energy-dense, nutrient-poor foods has increased among children and adolescents (Larson & Story, 2013; Piernas & Popkin, 2010).

Some studies investigated how eating behaviours are tracking over time. Tracking is defined "as a tendency of individuals to maintain their rank or position in a group over time" (Malina, 1996). A systematic review on tracking food intake from adolescence to adulthood found evidence that food consumption tends to track over these life stages (Craigie et al., 2011). According to this review, correlations of FV intake between the baseline and the follow-up varied from .26 and .33. On this review, only two of the studies included investigated the tracking of foods containing sugar and/or fat and poor to no correlation was found between the baseline and the follow-up. The tracking of eating behaviour has been widely explored from adolescence to adulthood, however, studies focusing on the transition from childhood to adolescence are lacking. Despite some evidence on the decline of quality of eating behaviours during the transition from childhood to adolescence (Lytle et al.; Mannino et al., 2004), very few studies investigated tracking of FV intake but those which have also found a moderate tracking of FV intake (Resnicow et al., 1998; Wang et al., 2002). If eating behaviours track from adolescence to adulthood, it seems clear that research is needed to better understand what influence these behaviours in adolescence in order to promote healthy eating.

To develop effective interventions aiming at improving healthy eating and to reduce the intake of unhealthy food, it is also essential to understand the factors that influence eating behaviours. In a systematic review McClain et al. (2009) investigated psychosocial factors of eating behaviours in young people (under 18 years), and included seventy seven studies (83% of them cross-sectional). This review found that the factors that more often influenced positively the consumption of fruit, vegetables and/or juices were intentions to eat, knowledge, liking, preferences and perceived modelling. For “less healthy dietary consumption”, intentions and perceived modelling were the most frequent factors influencing positively the intake of this type of food. For sugar snacking, attitudes and intentions were the only two consistent variables influencing positively this outcome. Therefore, several factors have been identified as consistently influencing eating behaviours. However, none of the studies included in this systematic review were longitudinal and, consequently, the evidence for causal relationships is suggestive at best. In addition, the authors did not divide children and adolescents’ results/studies into distinct categories when reporting results. This limits the understanding of specific correlates of eating behaviours in each one of these developmental stages. Furthermore no studies have explored how the predictors of eating behaviours in childhood influence the predictors of these eating behaviours in adolescence. It is important to better understand these relationships, in order to target the predictors that more strongly influence, directly or indirectly, eating behaviours over time.

### 4.1.3 Aims

The aims of the present chapter are:

– Aim 1: To track healthy and unhealthy eating from childhood to adolescence;
– Aim 2: To explore the influence of food intake and its predictors in childhood on eating behaviours and their predictors in

adolescence. Three eating behaviours in adolescence will be explored:

- *Food choice;*
- *Healthy eating (food intake);*
- *Unhealthy eating (food intake).*

### 4.1.4 Methods

***Participants and Procedures***

The present research analysed a sub-sample of the Gateshead Millennium study (GMS; Parkinson, Pearce, et al., 2011), a British birth cohort study following 1029 children born in 1999/2000. The GMS collected information on the first year of life, during childhood and adolescence in several waves (15 altogether).

For the present chapter, two waves were used, the one assessing data during childhood (6-8years old) and the one assessing during adolescence (11-13years old). The variables analysed in this chapter were selected taking into account results presented on chapter 2.1 and 3.3. That is, only significant predictors of food intake in childhood (chapter 2.1.) and significant predictors of eating behaviours in adolescence (chapter 3.3) were included in the current chapter.

Two hundred and sixty parents and children were assessed, between October 2006 and December 2007. In the current chapter, child's knowledge about healthy eating, food preferences, trying and liking FV, as well as, food intake was analysed.

The assessments at the 6-8 years old wave were conducted in 3 different visits: 1) first home visit: where the study was explained to the parents and consent forms were collected. At this stage, a 4 day food diary (Adamson et al., 2003) assessing child intake was explained and given to the parents; 2) second home visit: the child's food diary was collected from the parents; and finally, 3) school visit: where the child completed a questionnaire assessing knowledge

about healthy eating, preferences, trying and liking FV. Child's height and weight was measured at either visit one or two.

For adolescent data, the 15th wave of the assessment of the GMS, three face to face assessments were conducted. The first two assessments were part of the standard assessment procedures of the GMS where food intake was assessed by a 24h recall (INTAKE24, Foster et al., 2014). During the standard consent procedures, parents were invited to also consent, on behalf of their adolescent, to an optional sub-study about food choice; adolescent assent was also requested. Between August 2012 and March 2013, those parents who had consented to the sub-study (*n*=367) were contacted. After being provided with full information about the sub-study, a total of 303 (82.56%) parents/adolescents consented/assented to participate in the sub-study. This food choice sub-study took place one to six months after the second visit of wave 15. Some participants were not assessed on food intake due to their absence at school when the GMS team conducted data collection at school. Therefore, of the 303 participants, only 274 were assessed on food intake in the standard assessment procedure of the GMS. In order to offer families the option of data collection on school premises for the food choice sub-study, collaborating GMS schools were contacted. Eight of the nine schools agreed to participate. Overall, 64% of participants were assessed in their schools, 35% were assessed at home and 1% was assessed at Newcastle University.

Data from both waves (6-8 years old and 11-13 years old) was available for 210 participants when considering food choice, this number decreased to 193 when considering food intake.

## *Measures*

### *Measures assessed in childhood (6-8 years old - appendix B):*

Level of deprivation was calculated from the postcodes of participants in the 15th wave of the GMS. The postcodes were converted to the Index of Multiple Deprivation (IMD) 2007 using the UK data service census support website (http://geoconvert.mimas.ac.uk/). IMD measures deprivation levels in England based on the geography Lower layer Super Output Area (LSOA) where the most deprived LSOA for each Index is given a rank of 1 and the least deprived LSOA is given a rank of 32,482 (Noble et al., 2007). Lower scores in this variable means more deprived areas.

Weight status: Height was measured to 0.1 cm with a Leicester Portable height measure and weight measured to 0.1 kg with a TANITA TBF 300MA. Body mass index (BMI) was calculated and classified as obese, overweight or healthy weight according with the IOTF growth chart cut-offs – called BMI z-scores – which takes into account the age, sex, height and weight of the participant (Cole et al., 2000).

*Child food intake* was assessed through the Food Assessment in Schools Tool (FAST) validated by Adamson et al. (2003). FAST is a combination of a food frequency and food diary in which all foods and drinks consumed over 4 days were recorded. For each day, a list of foods frequently eaten by children aged 6-8 years old (based on results for these age groups in the national diet and nutrition survey) was presented in each of 6 timeslots (Gregory & Lowe, 2000). Each section also had a free text area where foods not appearing in the frequency lists could be recorded. Foods consumed by the child were recorded over 4 days – 2 weekend days and 2 school days. Parents recorded intake at home while trained lay observers recorded food intake at school. Only data from the mean daily frequency of healthy

(fruits and vegetables) and unhealthy (sugary, energy-dense, savoury) foods[7] was used (using results from both parental record of child intake and observers record of school food intake). Higher scores in each of these variables mean higher intake of the food group.

The measures related to *knowledge, liking*, *trying* and *preferences*, were assessed using the questionnaire "thinking about food" (Schagen et al., 2005). This questionnaire was developed in 2003 by the National Foundation for Educational Research in collaboration with the University of Leeds to evaluate the impact of School Fruit and Vegetable Scheme. Briefly, this scheme offered a free piece of fruit or vegetable to children aged four to six years in more than 500 schools between 2000 and 2001. In 2004, this scheme was expanded to England to distribute around 440 million pieces of FV each year to over two million children in 18,000 schools (Schagen et al., 2005). Further details of each measure assessed here are presented below.

*Trying and liking FV* was assessed by showing the child 12 images of fruits and 12 images vegetables (Schagen et al., 2005), the child was asked to mark a cross if they had not tried and, if they had tried, the participants were asked to indicate whether they liked each of the foods shown, did not like them or if they were not sure whether they liked it or not (Figure 4.1-1). From these questions 4 variables were computed: 1) trying fruits; 2) liking fruits; 3) trying vegetables, and 4) liking vegetables. The scores of these variables were calculated by addition of the number of fruits tried (for the trying variables) and liked (for the liking variables), leading to a scale ranging from 0 to 12, for each of the variables (liking and trying either vegetables or fruits). Therefore, higher scores indicate that the child tried (for the trying variables) or liked (for the liking variables) more fruits or vegetables.

[7] A detailed list of food included in healthy food and unhealthy food can be found in appendix A

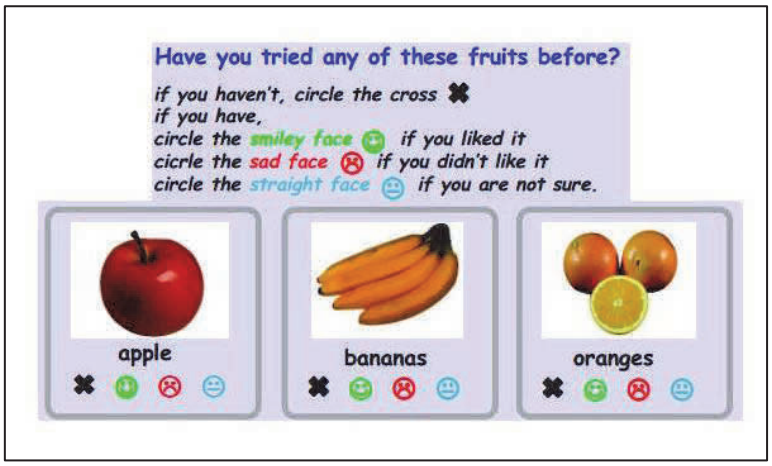


**Figure 4.1-1 - Example of the measures trying and liking fruits.**

*Food preferences* between healthy and unhealthy foods were evaluated by asking the child to choose their favourite food from a selection of five pairs (one healthy and one unhealthy food) – Figure 4.1-2 (Schagen et al., 2005).

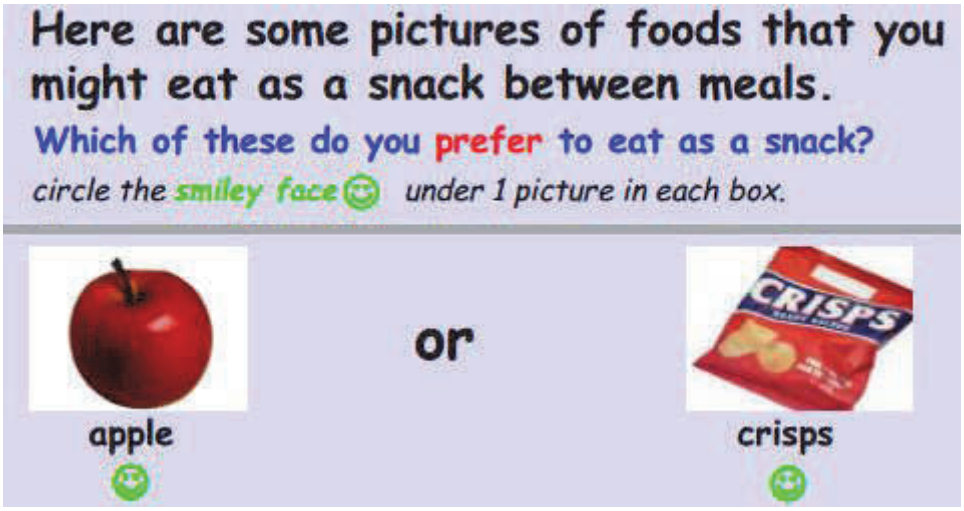


**Figure 4.1-2 - Example of the measure food preferences**

*Knowledge about healthy eating* was assessed through 3 different questions (Schagen et al., 2005):

– Choosing a healthy snack: The child was asked to select the healthiest foods from a range of three foods combinations in 5 different items. The scale ranged from 0 to 5, where higher scores mean more knowledge about healthy foods

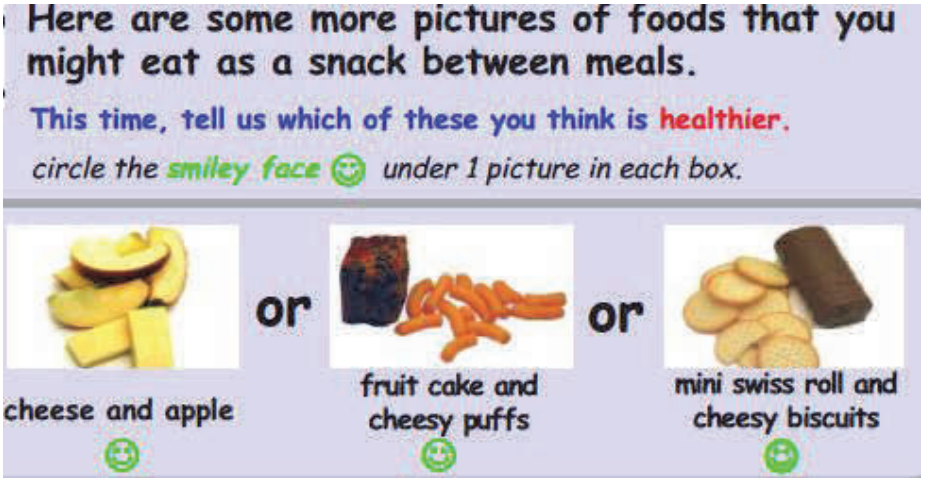


**Figure 4.1-3 - Example of the question choosing a healthy snack from the measure knowledge about healthy eating.**

– A balanced and healthy diet: the child indicated how much of ten different foods/drinks should be eaten in order to have a balanced and healthy diet. The child had three answers options: 1) “a person should eat lots”, 2) “a person should eat some” and 3) “a person should eat small amount”. For each correct answer, one mark was given. Correct answers were counted, and so the scale for the variable ranged 0 to 10, where higher scores indicate greater knowledge about a balanced and healthy diet.

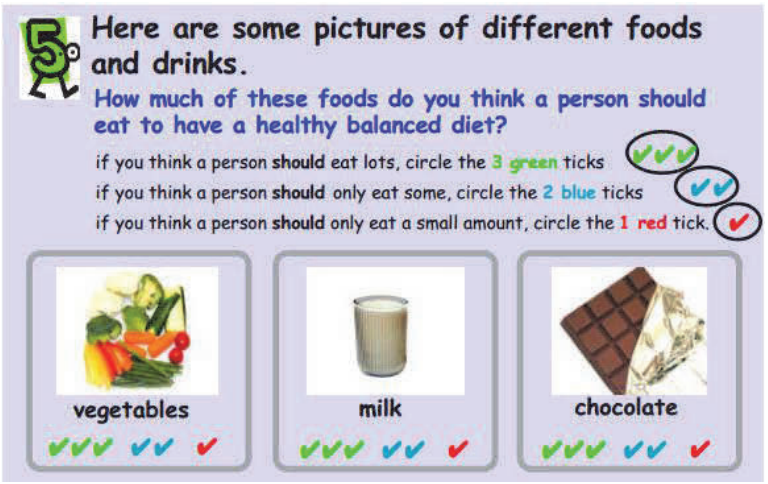


**Figure 4.1-4 - Example of the question: “balanced and healthy diet” from the measure knowledge about healthy eating.**

– Food that counts as a portion of fruit: 9 pictures of food/drink items were shown to the participants. Participants were then asked to indicate whether the item ‘did count’, ‘did not count’ or if they were ‘not sure’ if the food counted as a portion of fruit. The

final score ranged from 0 to 9, where higher scores indicate a greater knowledge about which foods counts as a portion of fruit.

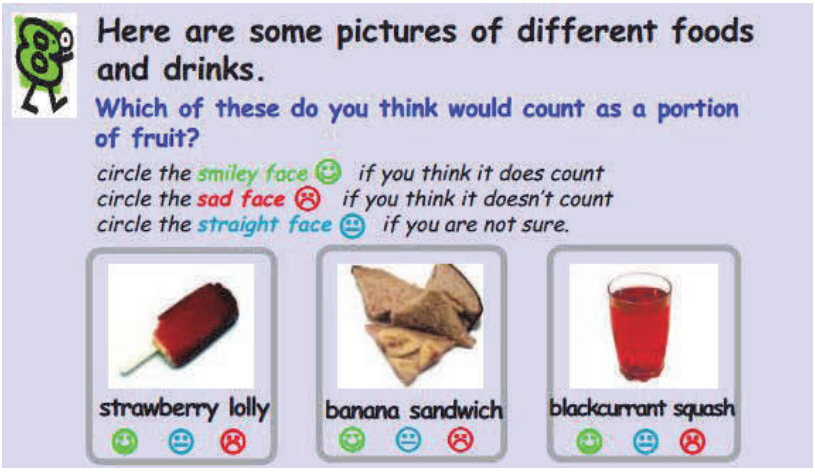


**Figure 4.1-5 - Example of the question: "Food that counts as a portion of fruit" from the measure knowledge about healthy eating.**

General level of knowledge about healthy eating was calculated from the previous 3 questions, results ranging from 0 to 24 points, the maximum score indicating the highest level of knowledge about healthy eating.

***Measures assessed in adolescence (12-13 years old – Appendix E):***

*Weight status*: Height was measured to 0.1 cm with a Leicester Portable height measure and weight measured to 0.1 kg with a TANITA TBF 300MA. Body mass index (BMI) was calculated and classified as obese, overweight or healthy weight according with the IOTF growth chart cut-offs – called BMI z-scores – which takes into account the age, sex, height and weight of the participant (Cole et al., 2000). Two participants declined to be measured.

*Food choice sub-study*

The measures used here were attempting at assessing reflective and impulsive measures, using a dual-process model, which could potentially act as predictors of food intake and food choice (for further detail check chapters 3.2. and 3.3.).

*Reflective measures*

*Intention:* Three items each were used to assess *intention* to eat healthy (e.g. I intend to eat fruits and/or vegetables as snacks, between main meals; $\alpha$ = .71) and unhealthy foods (e.g. I intend to eat sweet/savoury snacks, between main meals; $\alpha$ = .71).

*Perceived Behavioural Control* (PBC) was assessed with three items for healthy food (e.g. If I wanted to I could eat fruits and/or vegetables as snacks, between main meals; $\alpha$ = .51) and two items for unhealthy foods (e.g. If I wanted to I could eat sweet/savoury snacks, between main meals; $\alpha$ = .63).

The intention and PBC items were based on standard assessment procedures (based on Ajzen, 2002) and responses were given on a five point scale (from 1 = definitely true to 5 = definitely not true) and scaled as the average response across items (separately for healthy and unhealthy). Higher scores indicated higher level of intention and PBC.

*Impulsive measures:*

*Temptation:* Fifteen healthy foods and 15 unhealthy food that can be eaten as snacks that were mostly eaten by children aged 11-12 in the North East of England (Adamson et al., 2011)[8] were selected to be used within the impulsive measures – Table 4.1-1 – and a picture of each food was produced (see appendix F) to assess *temptation.* Participants were asked to evaluate 15 healthy ($\alpha$ = .84) and 15 unhealthy foods ($\alpha$ = .87) according to the level of temptation attributed to the food represented in the image: "To me, [food illustrated on the screen] is a temptation, difficult to resist eating"; 1 = strongly disagree; 5 = strongly agree (based on Kroese et al., 2011). Scales for statistical analysis were computed using the average of the items (separately for temptation to eat healthy and unhealthy food). Higher scores indicated higher level of temptation.

[8] Participants in the Adamson et al., 2011 study were very similar to the study in the current chapter and did not differ regarding sex ($p$=.43) and BMI ($p$=.06). However, the sample of the present study lived in more deprived areas ($p$<.001).

**Table 4.1-1 – Food selected for measuring temptation.**

| Healthy | Unhealthy |
|---|---|
| Apple | Boiled sweets |
| Banana | Crisps |
| Carrot | Flapjack |
| Kiwi | Chocolate cake |
| Orange | Chocolate biscuits |
| Grape | Sausage roll |
| Pear | Pizza |
| Cherry | Chips |
| Strawberry | Digestive biscuits |
| Tomato | Jellies |
| Cucumber | Crispy cake |
| Raisins | Coco pops |
| Pineapple | Potato waffle |
| Peach | Chocolate |
| Melon | Cereal bar |

*Executive Function measures:*

*Inhibitory Control* was assessed using the stop-signal paradigm in the Inquisit software©, on a 13.3" screen laptop. This involved two concurrent tasks: a go-task and a stop-task (Verbruggen et al., 2008). During the go-trials participants were instructed to discriminate whether an arrow was pointing to the left or to the right, pressing the "D" (left) or "K" (right) key on the keyboard as fast as possible depending on the direction of the stimulus (the arrow). In turn, the stop-trials involved the presentation of an auditory signal that indicated to participants to inhibit their response to the arrow (**Erro! A origem da referência não foi encontrada.**).

Each participant completed one practice block of 32 practice trials followed by 3 blocks of 64 actual trials each which included 25% of stop-trials. All blocks started with a fixation sign which remained for 250 ms, subsequently the stimulus (i.e. the arrow) appeared until the participant responded or until 1250 ms had passed. An interval of 2000 ms was included between the stimulus and of 10 seconds between blocks.

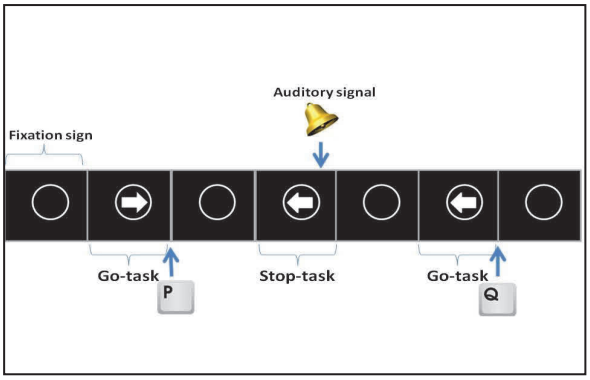


**Figure 4.1-6 – Stop-Signal Task procedure**

Reaction time to respond to the stimulus was recorded. The stop-signal was presented in a variable stop signal delay (SSD), i.e. the delay between the go-task stimulus (arrow) and the stop signal (auditory signal). At first, the SSD occurred at 250 ms and was adjusted continuously according to the performance of the participant: when the inhibition was successful the SSD increased by 50 ms, however, when the inhibition failed the SSD decreased by 50 ms. Also, the software estimated a stop-signal reaction time (SSRT) by subtracting mean SSD from the mean reaction time (Logan et al., 1997). SSRT is the most important variable of this task, and was inverted for a better understanding of the results. That is, lower scores indicating less inhibitory control skills. Five participants were excluded due to hardware problems.

*Environmental measures:*

*Availability of food at home*: was assessed by asking the participants to rate the availability of healthy (How often do you have fruits and/or vegetables as snack at home?) and unhealthy food (How often do you have sweet/savoury snacks at home?) at home (adapted from Neumark-Sztainer et al., 2003) and the access to both types of food that parents gave them (How often do your parents give you fruits and/or vegetables to eat as a snack between main meals? And same question for unhealthy food). Therefore, this variable included 2 items ($\alpha$ = .64 for both type of food) for each type of food and ratings were

given on a five points scale, from never (1) to always (5). Higher scores reveal more availability of food at home.

*Outcomes: Eating behaviours*

*Food choice:* The Behavioural Choice Task © (Lappalainen & Epstein, 1990) was used to assess food choice. Before task was initiated participants were asked: "At this moment, how hungry are you?"; scaled 1 = not at all to 5 = very much (Piech et al., 2010). This allowed controlling hunger in the statistical analysis and guarantying that the choice was not influenced by hunger. To conduct the task a selection of 8 food images with good availability across seasons for each type of food (from the 15 healthy and unhealthy foods selected for assessing temptation – Table 4.1-1) was used. The healthy food options were 1) apple, 2) banana, 3) carrot, 4) kiwi, 5) orange, 6) grape, 7) pear, 8) cucumber and the unhealthy food options were 1) boiled sweets, 2) crisps, 3) flapjacks, 4) chocolate biscuits, 5) jellies, 6) crispy cake, 7) coco pops, 8) chocolate. Before the task, portions of each food were shown to make sure that participants understood the type and size of each reward. Participants had the chance to choose between both types of food before each of the trials. The task consists of two sets of three boxes in which different shapes and colours rotate every time the mouse button is pressed (like a slot machine) – Figure 4.1-7. The participant gets one point every time the shapes match in colour and shape. It was also explained that 15 points (each trial) earned would be exchanged for 1 portion of a chosen food. The task included 5 trials.

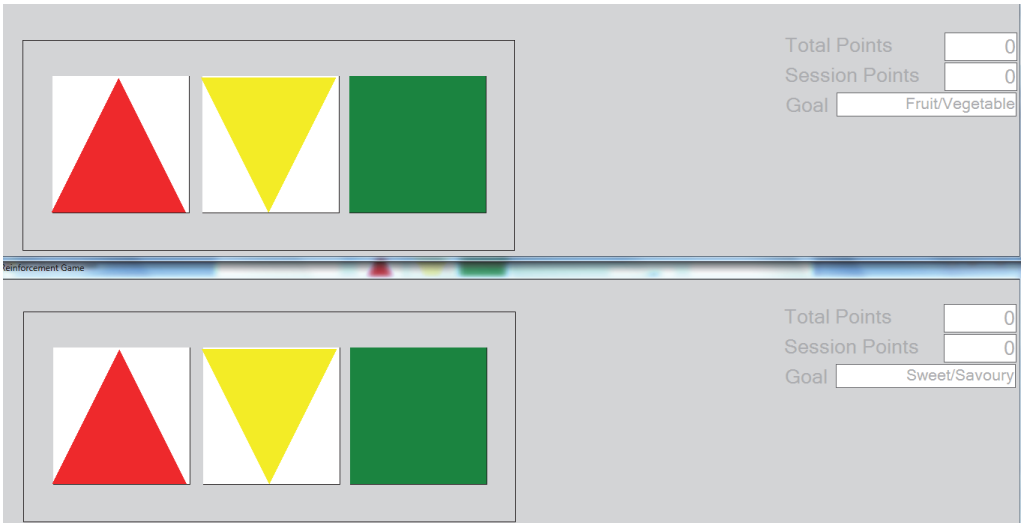


**Figure 4.1-7 – Behavioural Choice Task**

The task began with a concurrent schedule VR2/VR2 (the participants got on average one point every 2 responses for both schedules, i.e. for either choice: healthy or unhealthy food), after this, schedules doubled across the four subsequent trials from VR4 to VR32 for the reinforcer (i.e. healthy or unhealthy) chosen and consequently behavioural costs increased. However, the schedule remained the same when the reinforcer was not chosen. Therefore, the adolescents chose those foods that more motivated them to work on the task.

This task allowed calculating the amount of each type food chosen; scale ranging from 0 to 5 portions. Because the total amount of food after the task (5 trials) can only be 5 portions, if the amount of healthy food portions is known, (e.g. 3 portions of the healthy option achieved by the end of the task) then the amount of unhealthy portion of food can easily be calculated (2 portions of unhealthy portions). For this reason, only data from healthy food will be reported from here on for this specific variable (food choice).

*Food intake* was part of the standard measures of GMS which was measured retrospectively using a 24h recall food diary collected via INTAKE24 software (Foster et al., 2014). This software follows the 24h multiple pass recall procedure and allows participants to report all food and drinks consumed in the preceding day (from before

breakfast to after the evening meal), as well as the amount consumed (portion size) and time. Each participant completed 2 x 24h recalls with at least one week interval between both assessments. Fifty eight participants completed only one 24h recall. The output used for the present study was the average frequency of healthy and unhealthy (list of the food can be found in appendix A).

### 4.1.5 Statistical Procedure

All standard statistical analyses were done using the Statistical Package for the Social Sciences 19 (SPSS) while path analyses were done in AMOS 17.0 (SPSS Inc, Chicago, IL).

To investigate the strength of a possible relationship, a Spearman correlations was done (aim 1 – tracking food intake from childhood to adolescence), due to non normal distribution in the childhood data. Because tracking refers to the propensity of individuals to remain in a given position/rank in a group over time (Malina, 1996), a percentile analysis was done. For this food intake in childhood and food intake in adolescence were divided into three groups based on their intake (called tertiles). The comparisons between the position of participants in childhood and their position in adolescence was analysed through stacked bars to explore if children remain in the same tertile of food intake 5 years later. Lower tertile indicated worst eating behaviours.

The second aim was to explore the influence of food intake and its predictors in childhood on eating behaviours and their predictors in adolescence. In chapter 2.1., a path analysis was done to explain what and how predictors influence children's food intake and in chapter 3.3 the similar analysis were done for adolescents' eating behaviours. The final models found in each chapter were used as the basis of the analyses presented in this chapter. That is, food intake and its predictors at the age of 6-8 years (childhood) were related to predictors and eating behaviours in adolescence. Again, eating behaviours defined as: 1) food choice; 2) healthy eating and 3) unhealthy eating.

Model fit was assessed using model chi-square, comparative fit index (CFI), root mean square error approximate (RMSEA) and standardized root mean square residual (SRMR). Adequate fit was defined as chi-square *p*-value over .05, CFI over .95, RMSEA below .07 and SRMR below .08, GFI over .95 (Hooper et al., 2008). Participants with missing data in any measure included in each model were excluded.

Standardised beta coefficients (β) were derived for each explanatory variable in order to allow comparing and estimating the relative importance of each measure (i.e. a standardised coefficient is the SD change in child's food intake elicited by a 1 SD change in the explanatory measure).

### 4.1.6 Results

The present chapter will focus on the results that link childhood to adolescence. More details about the specific models on food intake in childhood and eating behaviours in adolescence can be found elsewhere (section 2 and 3 of the thesis).

Overall, 210 participants presented full data available to analyse food choice, 52.9% were girls and 30% were overweight or obese. In the food choice task conducted during adolescence, participants chose on average the same portions of healthy and unhealthy food (*M=2.50; SD = .93)*.

For the data related to food intake, 193 participants were included (full data available), 52.3% were girls and 31.6% were overweight or obese. In adolescence participants reported eating on average 1.05 healthy foods and 1.70 unhealthy foods a day.

***Tracking food intake from childhood to adolescence***

Healthy eating at the age of 6-8 years old was positively correlated with healthy eating in adolescence ($r$ = .21; $p$ = .003). The stacked bars (Figure 4.1-8) show that 55.4% of the children from the first tertile remained in the first tertile in adolescence; 45.5% of those from

the second tertile in childhood remained in the second tertile during adolescence and 25.8% of children of the third tertile remained in the same tertile in adolescence.

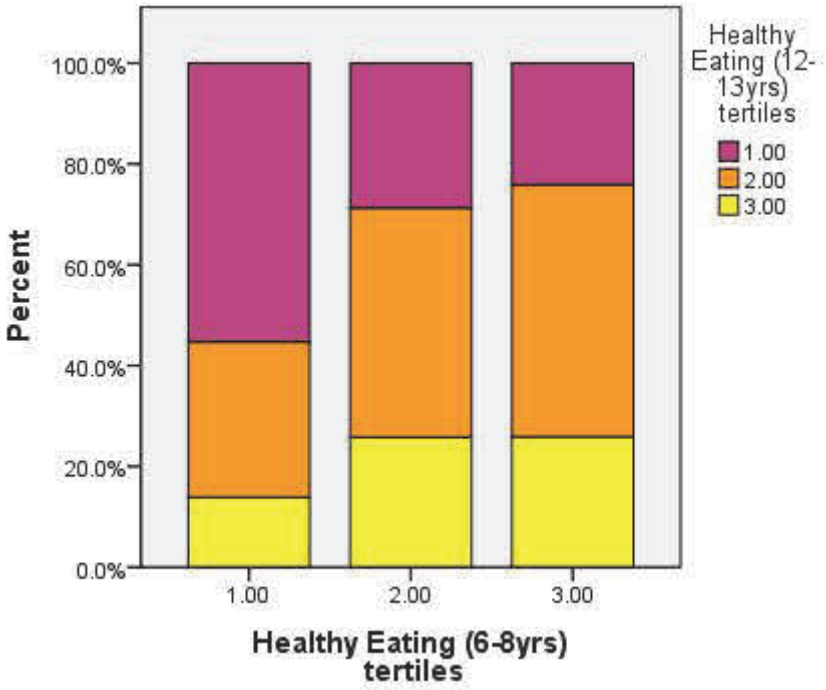


**Figure 4.1-8 - Maintenance of tertile position for healthy eating at the age of 6-8years old vs. 12-13 years old**

Unhealthy eating in childhood was positively correlated with unhealthy eating in adolescence ($r$ = .14; $p$ = .003). The correlation was quite weak, indicating that the tracking of unhealthy eating is not very strong. Less than half of the sample in childhood remained in the same tertile in adolescence (Figure 4.1-9). That is, 45.9% of the children from the first tertile remained in the first tertile in adolescence; 26.2% of those from the second tertile in childhood remain in the second tertile at adolescence and 29.3% of children of the third tertile remained in the same tertile in adolescence.

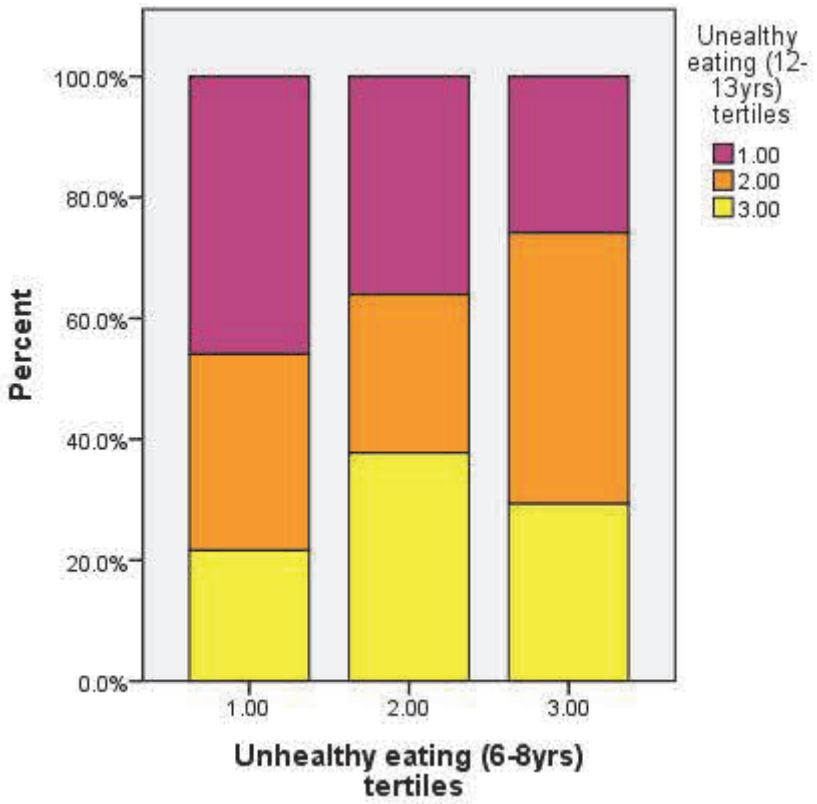


**Figure 4.1-9 - Maintenance of tertile position for unhealthy eating at the age of 6-8years old vs. 12-13 years old**

### *Exploring the influence of predictors of food intake in childhood on the predictors of eating behaviours in adolescence.*

#### *Outcome: food choice in adolescence*

The final model is represented in Figure 4.1-10 (Appendix I – for further details on how the final model was derived from successive steps) where the standardised direct effect of each significant relationship is presented, as well as the standardised total effect of each variable (i.e., including both the direct effect and indirect effects mediated through other variables). The overall model explained 34% of the variation in food choice and presented a good fit.

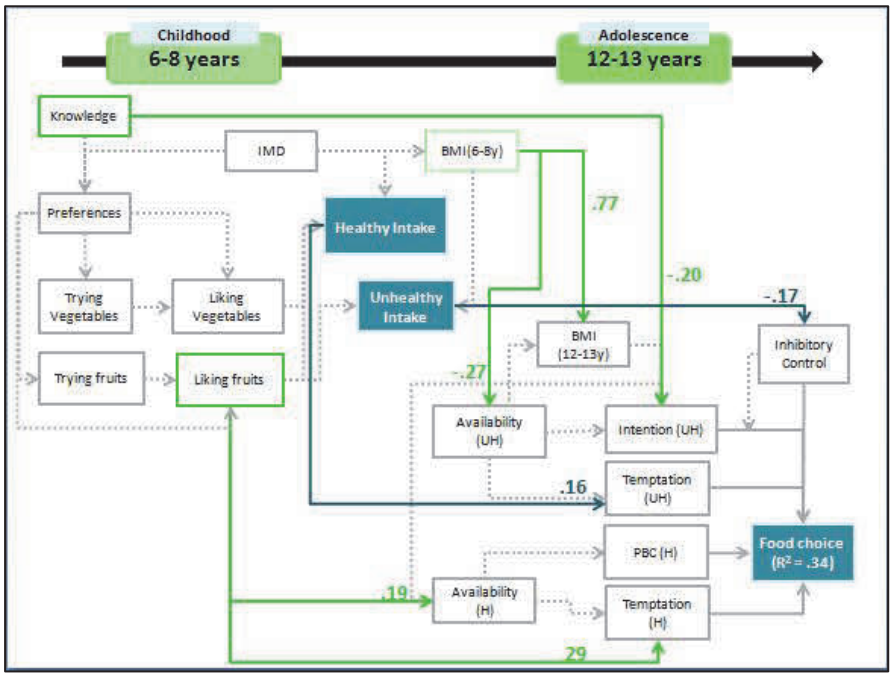


**Figure 4.1-10 – Path diagram showing the relationship between food intake and its predictors in childhood on food choice and its predictors in adolescence.**

*Note: Model of childhood's food intake and adolescent's food choice are based on the results of the chapter 2.1 and 3.3, respectively. Significant relationships within each of the models are represented by grey arrows. Each variable from the childhood model added to the adolescence model was related to all variable of this former. However, only significant effects (p<.05) which are represented by black arrows were drawn in order to simplify the diagrams. Path diagrams showing indirect effects of childhood variables on adolescents' food choice. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients (β) are presented above each arrow. In the final model, the standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name. Model fit: $\chi^2(147) = 165.522$, p = .14, RMSEA = .03 [90%CI = .00, .04], GFI = .93, CFI = .98. N = 210.*

*Direct effects:*

There was no direct effect on food choice in adolescence.

*Association between variables from childhood and predictors of food choice in adolescence:*

Healthy eating at the age of 6-8 years old was positively associated with temptation to eat unhealthy food in adolescence (β = .16; *p* = .013), whereas unhealthy eating at the age of 6-8 was negatively associated with inhibitory control (β = -.17; *p* = .013). Furthermore, BMI in childhood was strongly positively associated with BMI in adolescence (β = .77; *p* < .001) and negatively associated with availability of unhealthy food at home (β = -.27; *p* < .001). Knowledge about healthy eating during childhood was associated with less

intentions to eat unhealthy food during adolescence (β = -.20; *p* < .001). Finally, liking fruits as a child was associated with more healthy food available at home during adolescence (β = .19; *p* = .005) and more temptation to eat healthily (β = .29; *p* < .001).

### *Outcome: healthy eating in adolescence*

The final model is represented in Figure 4.1-11 (Appendix J for further details on how the final model was derived) where the standardised direct effect of each significant relationship is presented, as well as the standardised total effect of each variable (i.e., including both the direct effect and indirect effects mediated through other variables). The overall model explained 12% of the variation in healthy eating and presented a good fit.

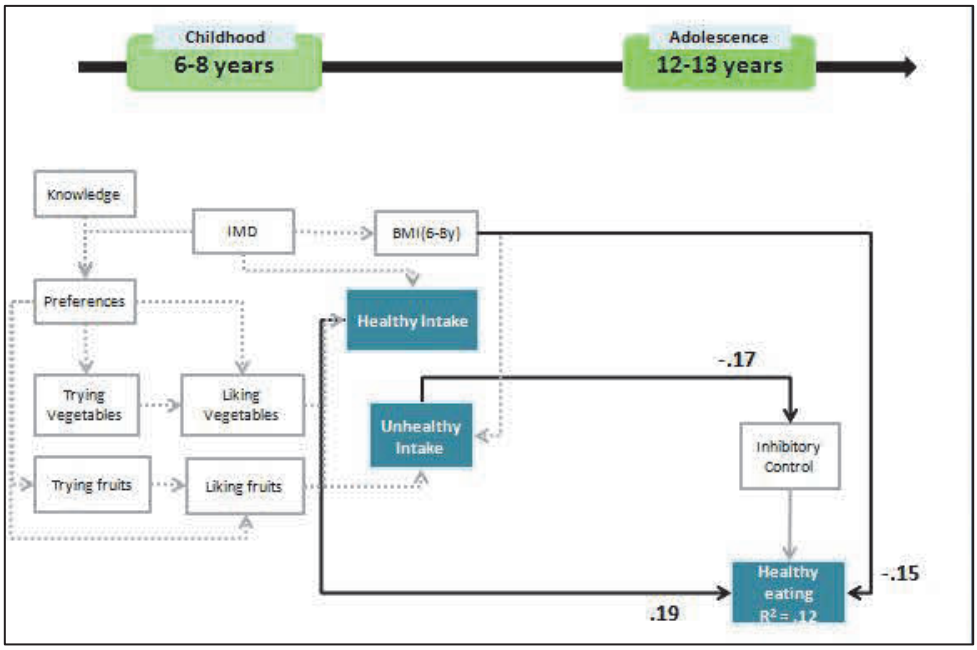


**Figure 4.1-11 - Path diagram showing the relationship between healthy eating and its predictors in childhood on healthy eating and its predictors in adolescence.**

*Note:Model of childhood's food intake and of adolescent's healthy eating are based on the results of the chapter 2.1 and 3.3, respectively. Relationships within each of the models are represented by grey arrows. Each variable from the childhood model was related to all variables of the adolescence model. However, only significant effects (p<.05) which are represented by black arrows were drawn in order to simplify the diagrams. Path diagrams showing direct and indirect effects of childhood variables on adolescents' healthy eating. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients (β) are presented above each arrow. In the final model, the standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name. Model fit: $\chi^2(46) = 51.35$, p = .27, RMSEA = .03 [90%CI = .00, .06], GFI = .96, CFI = .99. N = 193.*

*Direct effects:*

Children with lower BMI (β = -.15; *p* = .024) and eating healthier (β = .19; *p* = .006) tended to eat more healthy food in adolescence.

*Association between variables from childhood and predictors of healthy eating in adolescence:*

Unhealthy eating at the age of 6-8 was negatively associated with inhibitory control (β = -.17; *p* = .016) during adolescence.

***Outcome: Unhealthy eating in adolescence***

The final model is represented in the Figure 4.1-12 (Appendix H for further details on how the final model was derived) where the standardised direct effect of each significant relationship is presented, as well as the standardised total effect of each variable (i.e., including both the direct effect and indirect effects mediated through other variables). The overall model explained 15% of the variation in unhealthy eating and presented a good fit.

*Direct effects:*

Preferences over healthy food in childhood was negatively associated with unhealthy eating in adolescence (β = -.17; *p* = .011).

*Association between variables from childhood and predictors of unhealthy eating in adolescence:*

Unhealthy eating at the age of 6-8 was negatively associated with inhibitory control (β = -.17; *p* = .016). Furthermore, BMI in childhood was negatively associated with availability of unhealthy food at home in adolescence (β = -.28; *p* < .001).

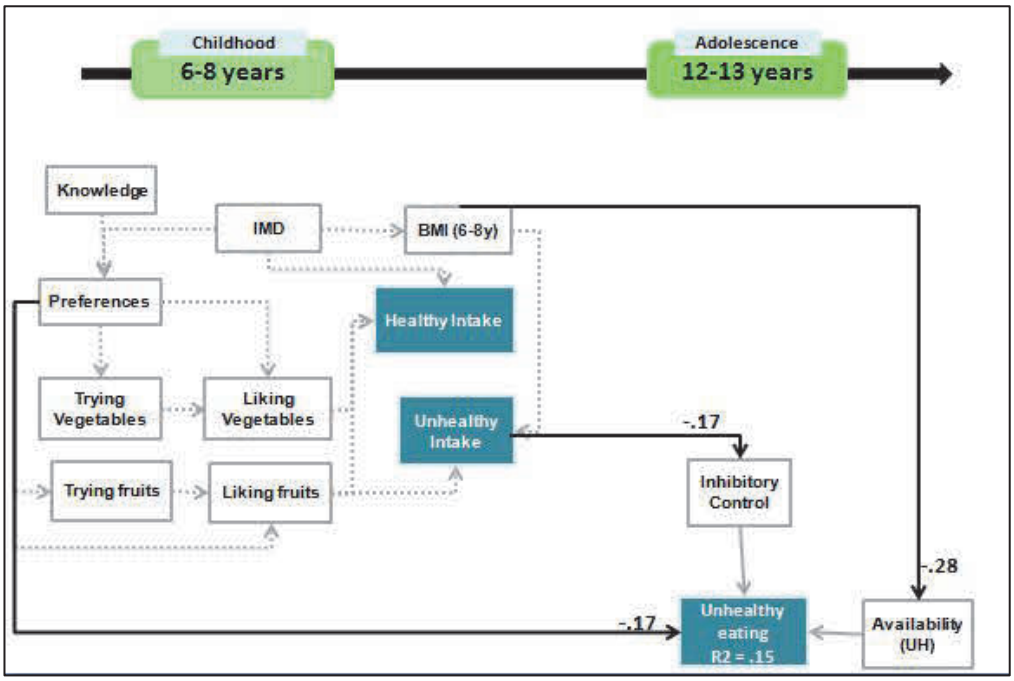


**Figure 4.1-12 - Path diagram showing the relationship between unhealthy eating and its predictors in childhood on unhealthy eating and its predictors in adolescence.**
*Note: Model of childhood's food intake and of adolescent's unhealthy eating are based on the results of the chapter 2.1 and 3.3, respectively. Relationships within each of the models are represented by grey arrows. Each variable from the childhood model was related to all variables of the adolescence model. However, only significant effects (p<.05) which are represented by black arrows were drawn in order to simplify the diagrams. Path diagrams showing direct and indirect effects of childhood variables on adolescents' unhealthy eating. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients (β) are presented above each arrow. In the final model, the standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name. Model fit: $\chi^2(57) = 69.22$, $p = .13$, RMSEA = .03 [90%CI = .00, .06], GFI = .95, CFI = .97. N = 193.*

### 4.1.7 Discussion

The current chapter aimed, firstly, to assess tracking of healthy and unhealthy eating from childhood to adolescence, secondly, to explore the influence of predictors of food intake assessed during childhood on food choice and food intake in adolescence. It also aimed to assess the relationships between predictors of food intake during childhood and predictors of eating behaviours (food intake and food choice) in adolescence.

Results on tracking showed that healthy eating tracked moderately from childhood to adolescence but found low tracking of unhealthy eating. These results are in line with Wang et al. (2002) who found

similar results when tracking FV consumption, where 44% of those eating higher number of FV at the age of 9-13 remained higher FV eaters 6 years later and 33% of those eating low number of FV at the age of 9-13 remained lower FV eaters. Furthermore, a systematic review on tracking food intake from childhood to adulthood also found moderate correlations of FV intake between baseline and follow-up (Craigie et al., 2011). Nevertheless, and in contrast to the previously mentioned systematic review where no correlation between baseline and follow-up on foods containing sugar and/or fat was seen, the results showed a low correlation. Although food intake shows some tracking, a large proportion of children seem to be changing their eating behaviours over time. Several factors may influence these changes. Between childhood and adolescence there are key differences on the control over food. Indeed, children's eating behaviours are often under control from their parents (or school) having less power in deciding what to eat (though they can leave food in their plate or request a repeat portion). Adolescents gain autonomy and may decide to start eating foods that were less available in the past. During adolescence parents cease to be the main role models, now peer approval is key and this might have an influence on adolescent's food choice and food intake. These changes may also be due to the long period between the two assessments (6-8; 12-13). Frémeaux et al. (2011) found that correlations between dietary patterns, from the age of 5 to 13, were strong when comparing dietary patterns with the interval of a year, but they tended to be weakened if more than one year was considered. This might indicate also some societal changes over the time when eating behaviours were assessed (Piernas & Popkin, 2010; Vereecken et al., 2015).

Path analyses assessing food choice in adolescence showed that the predictors of food intake in childhood were not directly associated with food choice. In contrast, the preference to eat healthy food at the age of 6-8 was directly and negatively associated with unhealthy

eating in adolescence. Children with lower BMI and eating healthier tended to eat more healthy food in adolescence.

Nevertheless, children eating more frequently healthy food tended to also be more tempted to eat unhealthy food in adolescence. Eating behaviours during childhood are often under parental control that may exert some pressure on their children to eat specific foods. Entering adolescence more autonomy is achieved. Having more freedom and some money means that adolescents, when making their choices on food may be influenced by several external factors, such as peer pressure and norms. Now that they can make their own choices, adolescents might feel more tempted to experience eating the food that is prohibited at home by parents.

Children eating more unhealthy food tended to present lower inhibitory control skills as measured during adolescence. Lack of inhibitory control skills have been mostly related to overweight and obesity (Thamotharan, Lange, Zale, Huffhines, & Fields, 2013) but very few studies have investigated its relationship with eating behaviours. For instance, Guerrieri et al. (2007) found that healthy adults with lower inhibitory skills ate more high calorie food comparing with those with higher skills. Moreover, Allan, Johnston, & Campbell (2011) explored the influence of inhibitory control (using the stop-signal task) on the intention-behaviour gap in food choices in adults, and showed that participants with lower cognitive control skills ate more snacks and less fruit and vegetables than they intended. To my best knowledge, no studies have explored the relationship between eating and inhibitory control in children and/or adolescents and the temporal nature of associations have not been investigated, making the results of the current chapter unique. Further research needs to be conducted to confirm (or not) the current results.

The main benefit of these findings relative to previous research is that relationships between predictors from childhood to adolescence were also explored. The strongest relationship was between BMI at

the age of 6-8 and BMI at the age of 12-13. Indeed, research has shown that weight status tracks over time (Singh, Mulder, Twisk, Van Mechelen, & Chinapaw, 2008). Further, higher levels of BMI during childhood were also associated with lesser availability of unhealthy food at home 5 years later. Most of the parents of the Gateshead Millennium Study were unable to identify that their child was overweight or "very overweight" at the age of 6-8 years old (Jones et al., 2012). However, the results of the current chapter seem to suggest that this perception might have changed over time and parents may be more aware of their child's weight issues and, so, reduce availability of unhealthy food at home. This might be due to the fact that overweight in childhood is associated with higher levels of BMI in adolescence and adulthood (Singh et al., 2008), and so, it might be easier for parents to identify weight problems on their children when they get older.

Liking fruits during childhood had a positive influence on temptation to eat healthy food, as well as on the availability of this type of food at home during adolescence. There is some evidence that children and adolescents tend to eat more the food that is readily available (Patrick & Nicklas, 2005). The current chapter suggests that this association between liking and availability seems to turn to a cyclic relationship. That is, children need to be exposed to food early in life to start liking it (Wardle, Herrera, et al., 2003; Wardle, Cooke, et al., 2003), and consequently, when parents realise that that children like the food, they seem to purchase it more frequently and make it available at home.

### *Strength and limitations*

Some limitations of the study presented in the chapter should be noted. Firstly, the dietary assessments in childhood and adolescence used different tools. Parents/observers reported eating consumption patterns during 4 days when children were 6-8 years old, whereas a 24h recall tool was answered directly by adolescents aged 12-13. This might explain the results on tracking and the lack of direct effect

between food intake in childhood and adolescent's food intake. The potential for error with using a significance level of .05 is also a limitation, since there is a 5% chance of error in finding a significant result (error type I). Further research replicating the model hypothesised in the present chapter would help to confirm and gain a consensus on results.

Despite these limitations, the current chapter shows the complexity of eating behaviours with several relationships between individual, social and environmental factors influencing directly or indirectly these behaviours. Additionally, results highlight the need of improving healthy eating and to reduce unhealthy eating early in life, due its shorter and longer terms consequences on eating behaviours and health. Further, investigating such a complex model provided useful information for future research and interventions which should consider including not only individual but also environmental and social strategies to improve eating behaviours.

# SECTION 5

# DISCUSSION

*Glossary Reminder:*

**Eating behaviours:** Set of behaviours assessed across the thesis and described below:

**Food choice:** This variable was assessed during adolescence via an experimental behavioural food choice task. Adolescents could obtain 5 portions of healthy, unhealthy or a mix of both food (that can be eaten as snacks). The results presented reflect the number of healthy choices made (from 0-5) which are the reverse of the number of unhealthy ones made (pictures of the food included in this task can be found in appendix G).

**Food Intake:** was assessed via a 4 days food diary (FAST) during childhood and via a 24h recall (INTAKE24) during adolescence. Two specific behaviours were analysed across the thesis (detailed list of food included can be found in appendix A):

- **Unhealthy eating:** consumption of sweet/savoury food that can be eaten as snacks (e.g. sweets, chocolate, cake, crisps)
- **Healthy eating:** consumption of fruit and vegetables.

**Predictors:** this term is used in order to facilitate reading. However, it is important to highlight that the analysis in this thesis cannot imply any causality assumption. Only associations between the variables assessed can be established.

# Chapter 5.1 General Discussion

Healthy eating is an important behaviour promoting health and well-being. However, children and adolescents tend to present unhealthy eating behaviours and do not meet current dietary guidelines particularly those for fruits and vegetables (Bates et al., 2011; Health and Social Care Information Centre, 2014; Piernas & Popkin, 2010; Vereecken et al., 2015). To support interventions promoting healthy eating, it is important to understand what factors influence eating behaviours in children and adolescents.

This thesis analysed the role of individual, environmental and social predictors of eating behaviours during childhood and adolescence. This thesis had three main aims, explored in each section of the thesis:

- **Section II:** To understand the relationships between predictors of food intake in childhood and their influence on healthy and unhealthy eating;
- **Section III:** To understand the relationships between predictors of eating behaviours (food choice and food intake) in adolescence and their influence on these behaviours
- **Section IV:** To understand how food intake and its predictors in childhood influence eating behaviours and their predictors in adolescence.

### 5.1.1 Comparison of the main findings to previous literature

As suggested by Sallis et al. (2008), eating behaviours are influenced by individual, social and environmental factors that are inter-related with each other. The importance of individual factors on eating behaviours in children and adolescents emerged in this study. Although the social and environmental factors assessed in the current study did not show a direct association with the behaviours (except for the prediction of unhealthy eating in childhood which was directly associated with level of deprivation – social factor), these factors were associated with individual factors, such as inhibitory control, intention and temptation to eat, having an indirect association with eating behaviours.

### *Predictors of food intake in childhood*

In childhood, liking FV was the variable that emerged as key in predicting healthier eating. Similar findings have been reported in previous studies (Brug, Tak, Velde, Bere, & de Bourdeaudhuij, 2008; Domel et al., 1996). Furthermore, many studies have found that previous food exposure to healthier foods influences liking, and consequently intake (see Cooke, 2007 for a review). In the current study, trying FV was indirectly related to food intake via liking FV. The more children reported having tried FV, the more they liked it and, as a result, the more they consumed this type of food. Children reporting to have tried more fruits tended to like it more and reported eating less unhealthy food. To my best knowledge, this result has not been reported in earlier studies.

Children living in more deprived areas tended to eat less healthy food. Social inequalities are a public health concern, given that people, whatever their age, living in more deprived areas are less likely to have eating patterns that follow the recommended guidelines (Rasmussen et al., 2006; Turrell & Vandevijvere, 2015; van Sluijs et al., 2008). This lack of healthy food intake has a negative impact on health (Boeing et al., 2012; He et al., 2006; Vainio & Weiderpass, 2006; WHO, 2002). Interventions in this area are warranted, particularly in young people since their eating patterns across the life span seem to be influenced by their eating patterns in childhood (Craigie et al., 2011).

Children with higher BMI tended to eat less unhealthy food. This result differs from those found in previous research (Hebestreit et al., 2014; Nicklas et al., 2003). It is known from previous analyses by Jones et al. (2012) that parents were not able to identify their child as overweight or ‘very overweight’ in the same cohort at the same age. This indicates that other reasons are behind the result found in the current study. For instance, it might indicate that those with higher BMI do not necessarily eat more frequently unhealthy food comparing with their healthy weight peers, but they may eat larger

portion sizes. Also, the unhealthy foods investigated in this thesis were limited not including all aspects of food intake. Besides, obese children may have unhealthier patterns of eating during main meals, or when eating other types of food that were not targeted or controlled for in this thesis. These hypotheses need to be explored in further studies.

### *Predictors of eating behaviours in adolescence*

Adolescents that reported having more healthy food available (environment factor) tended to also report higher perceived control over eating healthy food (individual-reflective factor) and higher levels of temptation to eat this type of food (individual-impulsive factor). Similar results were found when considering the presence of unhealthy food at home. Adolescents with more of these foods available presented higher intentions to health unhealthy foods as well as higher levels of temptation to eat unhealthily. People's food choices often occur with little conscious awareness on the influences brought by the environment (Wansink & Sobal, 2007). Indeed, in the current study, home environment was indirectly associated with food choices through the reflective and impulsive systems (individual level). Previous research might not have found direct effects, but a more global approach, i.e. integrating multilevel factors and exploring how they relate, could potentially show indirect paths between both variables as found in the current study. This might explain why previous reviews have found inconsistent results on the role of home environment on eating behaviours (McClain et al., 2009). The relationship between availability of unhealthy food at home and intention to eat unhealthily was also mediated by weight status. That is, participants reporting less unhealthy food at home, tended to have higher BMI, and those presenting higher BMI reported lesser intentions to eat unhealthy food. Similar to the results reported in childhood, this might indicate some awareness by those adolescents with higher BMIs which increase their deliberative decision (via intentions) to reduce unhealthy food intake.

Temptation was the strongest predictor of food choices. As part of the impulsive system, people are able to report their temptation level towards a specific food without requiring high cognitive efforts and can be triggered by an stimulus – in this study: a picture of the food (Hofmann, Friese, & Strack, 2009). The current results are in line with previous research that revealed that impulsive factors tended to be associated with quick choices comparing with deliberative behaviours or choices without time pressure (Malte Friese et al., 2006; Perugini, 2005). In the food choice task conducted as part of this thesis, there was not a clear time pressure, however, participants needed to make a choice under an experimental task, and may feel some pressure to choose relatively quickly. Under time pressure, people tend to make their choices according their accessible preferences (Fazio & Towles-Schwen, 1999). Further, as suggested by the bounded rationality (Kahneman, 2003; Simon, 1955), people make choices to satisfy their basic requirements rather than searching for the optimal option according to the available information. This may explain the strong relationship found between temptation and food choice.

Hofmann et al. (2008) suggest that the impulsive and reflective process may be influenced by boundaries conditions. In the current study, adolescents with higher inhibitory control skills restrained their intentions to eat unhealthy food and made healthier choices in the behavioural choice task. This also means that people with lower inhibitory skills have made unhealthier choices when they reported high intentions to eat unhealthily. Previous research in adults (Allan et al., 2010), found that people with lower inhibitory skills have eaten more chocolate than they intended. Hall and Fong (2007) suggested that people's engagement in an intended health behaviour that has short-term costs (e.g. restraining pleasure) and long-term benefits (e.g. improving health) depending on their self-regulatory capacity (including their inhibit control skills). Although executive function is still developing during adolescence (Anderson, 2002), the present thesis highlights the importance of this cognitive function on making

food choice decisions. Being able to inhibit behaviour seems to be crucial in controlling reflective processes related to intentions of eating unhealthy. To my best knowledge, these findings are the first in an adolescent sample. Consequently, further research is needed in order to better understand these relationships.

### *Predictors of eating behaviours from childhood to adolescence*

This study found a moderate tracking of healthy eating from childhood to adolescence, and a very low tracking for unhealthy eating. These results are in line with previous studies exploring tracking during adolescence (Wang et al., 2002) and from adolescence into adulthood (Craigie et al., 2011). Nevertheless, it is possible that tracking is underestimated in the current study due to different dietary assessments used in childhood and adolescence. Indeed, in younger participants, food intake was assessed through parental and observer ratings using a 4-days food diary, whereas in adolescence participants self-reported their intake of food over a 24h recall. This limitation is unavoidable since young children have limited skills to self-report their intake. However, it is important to take into account that it may limit tracking analyses. Research on tracking from childhood to adolescence is limited and, so, further studies are needed.

It seems that a virtuous circle may exist between trying fruits, liking fruits, availability of healthy food at home and the temptation to eat it. Children exposed to healthy food early in life have a greater chance of liking it (Wardle, Herrera, et al., 2003; Wardle, Cooke, et al., 2003) and, consequently, the fact that children like the food may influence parents' purchasing and making this food available at home. In turn, children and adolescents tend to feel more tempted and eat more of the food that is readily available (Patrick & Nicklas, 2005). These relationships give us some indications of the possible implications for practice.

Similarly to what was observed during adolescence, children with higher BMI reported having less unhealthy food available at home in

adolescence. Nevertheless, these children still tended to present higher BMI 5 years later. Although parents were not able to identify if their child was overweight during childhood in the same cohort (Jones et al., 2012), the results reported in the longitudinal section of this thesis seem to indicate that parents may be more aware of their adolescent's weight issues and reduce availability of unhealthy food at home. This might be due to the fact that overweight in childhood is associated with higher levels of BMI in adolescence (Singh et al., 2008), and so, it might be easier for parents to identify weight problems on their children when they get older. Further, adolescents themselves may also be aware of their weight and try to manage it by reducing unhealthy food intake. It is also important to highlight the fact that the researcher stayed in the same room during the experimental tasks might have produced results based on social desirability, particularly when considering the overweight/obese participants who are often stigmatised and may feel more social pressure to eat healthily. These results need to be further explored in future research.

The association between unhealthy eating during childhood and inhibitory control in adolescence was found to be significant in all eating behaviours explored in this study (food choice, healthy eating and unhealthy eating). That is, children eating more unhealthy food tended to present lower inhibitory control skills in adolescence. Lower inhibitory control skills have been previously related to overweight and obesity (Thamotharan et al., 2013) but very few studies have investigated its relationship with eating behaviours. Studies with adult samples found that people with lower inhibitory skills tend to make unhealthier food choices and eat more unhealthy food when compared to those with higher skills (Allan et al., 2011; Guerrieri et al., 2007). To the best of my knowledge, no studies have explored the relationship between inhibitory control and eating in children and adolescents or used a longitudinal design, making this result unique. Further research analysing these relationships would help to confirm and produce a consensus on the results.

### 5.1.2 Limitations of this study

***Dietary assessment***

All dietary assessments have some limitations and there is no consensus on which method most accurately reflects usual intake (McPherson et al., 2000; Thompson & Subar, 2013).

In this study, dietary records were used in childhood. Thompson and Subar (2013) suggest that recording food intake may increase people's awareness of consumption, which, consequently, may influence the intake itself. However, a systematic review of meta-analyses found no evidence of the influence of measurements in a single session on changing behaviour (Rodrigues et al., 2015). In childhood, food intake was measured by parents and observers, and so, even if parents would change their child's behaviour by reporting their intake, observers were trained as external examiners of children's intake, also contributing to limit the effect reported by Thompson and Subar (2013).

In adolescence, food choice was assessed in a laboratory context. This may reveal some ecological validity issues and may have influenced participants' choices due to the presence of the researcher in the room. To overcome this limitation it was explained to the adolescent that there was no right or wrong choice and no feedback (positive or negative) was given on their choices. Further, the food choice task used the most frequently eaten healthy and unhealthy food by adolescents in a previous study (Adamson et al., 2011). The advantage of using this type of assessment is that motivation to choose was controlled by asking the adolescents to work for their choice. In real life, people have intrinsic motivations to choose one specific food rather than the other, having them working for their preferences gave a good measure of their motivation levels. Finally, although food intake was assessed by using tools that assessed all meals and foods eaten, only two food groups (sweet/ savoury and FV) were selected to be used in this study given their

influence on overweight and obesity in children and adolescents (Rennie et al., 2005).

### *Predictors assessment*

Most of the predictors were assessed using a self-report measure and this can raise the potential for bias. However, measures used in the current study presented moderate-to-good reliability indices (when this was possible to analyse) and were the best and sometimes the only cost-effective and pragmatic forms of collecting the information needed.

Furthermore, the task used to assess attentional bias (chapter 3.1.) did not perform as expected and was then excluded from further analysis. This task was adapted from a study using an adult sample. Future studies that aim at exploring attentional bias will need to further refine the task used in this thesis so that it can be effectively used in younger people. This brings some implications for future research – as discussed below.

### *Methodology*

While the study did show a number of significant findings, it is also possible that some were missed due to a potential lack of statistical power, and, so, more research is warranted.

The potential for error when using a significance level of 0.05 is also a limitation, since there is a 5% chance of error of finding a significant result, that is finding a significant relationship when no such relationship exist (error type I). It is possible that some of the significant findings could be found by chance, however, they can often be spotted due to lack of meaning in the findings. Most of the significant results found in the current study were explainable.

Finally, the predictors of food choice explained a higher amount of variation than food intake predictors. This may be due to the time interval (one to six months) between the assessments of food intake and the predictors (Jaccard, 2012) – see chapter 3.2. for further discussion on this.

### 5.1.3 Strengths of the current study

Despite these limitations, the study is the first, to my best knowledge, that assessed predictors on eating behaviour from childhood to adolescence, integrating multilevel predictors at individual, social and environmental levels and a dual-process model. No studies have integrated reflective, impulsive and executive control or have explored their influence on eating behaviours in adolescents or explored what factors from childhood are associated with these processes. Indeed most of the studies exploring dual-process models are focused on adults and tend to assess only one of these processes with the exception of studies targeting the predictive effects of prototypes. Furthermore, no study has explored how childhood predictors are associated with predictors based on a dual-process model in adolescence. This study used a theoretical framework which can guide future interventions in supporting adolescents to make healthier food choices.

***Implications for practice and future research***

Complex relationships between the different predictors and eating behaviours were investigated and give some new insights for future research and practice.

The importance of exposure to food early in life seems clear from this study and previous research (Wardle, Herrera, et al., 2003; Wardle, Cooke, et al., 2003). Therefore, parents and school canteens should be incentivised to cook a diversity of FV and be aware that repeated exposure leads children to like this food more. By promoting liking of FV, interventions will also improve healthy eating. Further, parents may also be more motivated to buy this type of food when the child likes them and so is more likely to eat them. In the present study, it was found that exposure and liking of FV in childhood were associated with food availability and temptation to eat healthily in adolescence, which was associated with healthier choices.

Future interventions should take into account socio-economic status. Currently, there is limited evidence on how to decrease social inequalities in eating behaviours. Planning interventions targeting social inequalities is challenging due to the large number of multilevel factors interacting across the life span (Turrell & Vandevijvere, 2015). Future interventions should nevertheless aim at not increasing health inequalities but decreasing these by focusing on interventions that make FV available allowing children to try them, particularly in settings where children spend most of their time such as at school. A recent systematic review (Beauchamp, Backholer, Magliano, & Peeters, 2014) summarised results from interventions aiming at preventing obesity in children according to their socio-economic position (SEP). This review included 14 studies from developed countries. Results revealed that interventions based on individual behaviour change strategies were not effective in preventing obesity in populations from a lower SEP. In contrast, interventions including community-based strategies or policies targeting environmental changes (such as including fruit breaks at school, changing canteen's menu) showed to be effective in this population. Changing environments may give children the opportunity to access healthy food and maybe even change individual factors (temptation, intentions etc.), and consequently their eating behaviours.

Although giving information about healthy food might not influence food choice or food intake directly, some indirect influence of knowledge was found not only during childhood but also in adolescence. Thus, interventions targeting children may have some benefits in integrating information about healthy food.

In adolescence, educating parents/carers to reduce unhealthy food availability at home and increase healthy food may support adolescents in better controlling temptation and intention levels to eat unhealthily as well as, promote perceived behavioural control and allow them to enact on temptation to eat healthily.

It is important to highlight that implications of this study for practice are suggestive at best. Indeed, there is a lack of research that has tested such complex relationships in longitudinal studies, and so replications of this study are needed to corroborate (or not) the existence of the relationships found.

However, this research has described some interesting relationships that may have implications in practice if it they are confirmed by future research. For instance, children who tried more fruit tended to like these more and have reduced unhealthy eating in adolescence. Further, unhealthy eating in childhood influenced inhibitory control 5 years later. Children eating unhealthily tended to have worse inhibitory skills in adolescence and, in turn, make unhealthier choices. Exploring if inhibitory control influences long-term eating patterns is a hypothesis that the GMS could explore in future waves.

The GMS is also in a good position to explore the relationships between weight status, unhealthy eating, availability of unhealthy food and intention to eat unhealthily within its cohort. Indeed, this thesis found that children with a higher BMI tended, paradoxically, to eat less unhealthy food in childhood. In addition, children with higher BMIs tended to report having less unhealthy food at home in adolescence, as well as, less intentions to eat this type of food. Several conclusions may arise from these results that need to be explored, such as: 1) parents who were not able to identify their child as overweight or “very overweight” during childhood (Jones et al., 2012) may have changed their perception about the weight issues of their child during adolescence; 2) children and adolescents may be able to identify themselves as overweight/obese and control their own intake; 3) those with a higher BMI do not necessarily eat more unhealthy food in frequency, but may eat larger portion sizes and this was not assessed in this thesis; 4) unhealthy foods included in this thesis were limited and so overall patterns of eating might differ.

More research is needed on how to change temptation as it was the strongest predictor of food choice. In a review focused on the

impulsive system and health, Sheeran et al (2013) suggest some effective intervention procedures to change impulsive affects. For instance, the evaluative conditioning which consist in pairing a specific stimulus (e.g. a specific food) with another positive or negative stimulus (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010). Furthermore, approach–avoidance associations by training people to approach a healthy stimulus and avoid an unhealthy stimulus (Kemps, Tiggemann, Martin, & Elliott, 2013). Implementation intentions which consist on asking people to make "if-then" plans, that is, if a situation happens, how it can be overcome. For instance, Hofmann, Deutsch, Lancaster, and Banaji (2009) asked participants to think about temptation situations to eat chocolate and plan possible solutions to overcome this temptation. Results showed that, at the end of the experiment, participants were less favourable towards chocolate. All the procedures above were described as means to improve "implicit attitudes" because this factor has been widely studied as an impulsive factor, future research should explore if these procedures influence other types of impulsive factors, such as, temptation. Further, they have been mostly tested with adults highlighting the need to explore these concepts on younger samples.

Finally, research interested in exploring the role of attention bias in adolescence should consider the limitations found in the current study. For instance, it may be important to test the same procedure but altering the exposure time to the pictures and to the stimulus (triangles and circles). Furthermore adding an eye-track movement to the task would allow assessing attention with an objective measure on the movement of the eyes. That is, future studies should explore the best conditions that should be programmed in this task before using it in young people.

### 5.1.4 Conclusion

This study has added to the literature by providing information on the predictors of eating behaviours from childhood to adolescence by

using an ecological framework and a dual-process model. The current study brings some insights into the complexity of eating behaviours showing several relationships influencing directly or indirectly these behaviours.

Children are more likely to engage in healthy eating when they had the opportunity of trying healthy food that will promote their liking towards this type of food. In adolescence, the likelihood to make healthier choices is increased when they have higher control skills and when home environment offers the right opportunities which will influence their temptation to eat healthy food and their deliberative decision processes to engage in healthy eating.

# SECTION 6

# REFERENCES

### 6.1.1 References


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# SECTION 7

# APPENDICES

Appendix A

## Childhood (6-8 years old)

*Child's food intake in using food diary recoding 4 days (FAST) – (Adamson et al., 2003)*

| | |
|---|---|
| Healthy Eating | Fruits<br>Vegetables |
| Unhealthy Eating | Biscuits<br>Confectionary cakes, sweet puddings<br>Crisps and savoury snacks |

*Parents' food intake in using food frequency questionnaire – (Bingham et al., 1997)*

| | | |
|---|---|---|
| Unhealthy eating | Cereals | Sugar coated cerealsj e.g. Sugar Puffs, Cocoa Pops, Frosties |
| | Sweets & Snacks | Sweet biscuits, chocolate, e.g. digestive (one) |
| | | Sweet biscuits, plain, e.g. Nice, ginger (one) |
| | | Cakes e.g. fruit, sponge, sponge pudding, (medium serving) |
| | | Sweet buns & pastries e.g. flapjacks, doughnuts, Danish pastries, cream cakes (medium serving) |
| | | Fruit pies, tarts, crumbles (medium serving) |
| | | Ice cream, choc ices (one) |
| | | Chocolates (small bar or 1/4 pound of chocolates) |
| | | Chocolate snck bars e.g. Mars, Crunchie (one) |
| | | Sweets, toffees, mints (one packet) |
| | | Crisps or other snacks e.g. Wotsits (one packet) |

| | | |
|---|---|---|
| Healthy Eating | All Fruit | Apples |
| | | Pears |
| | | Oranges, Satsuma, mandarins, tangerines, clementines |
| | | Grapefruit |
| | | Bananas |
| | | Grapes |
| | | Melon |
| | | Peaches, plums, apricots, nectarines |
| | | Strawberries, raspberries, kiwi fruit |
| | | Tinned fruit |
| | | Dried fruit, e.g. raisins, prunes, figs |
| | All Vegetables | Carrots |
| | | Spinach |
| | | Broccoli |
| | | Brussels sprouts |
| | | Cabbage |
| | | Peas |
| | | Green beans, broad beans, runner beans |
| | | Marrow, courgettes |
| | | Cauliflower |
| | | Parsnips, turnips, swedes |
| | | Leeks |
| | | Onions |
| | | Garlic |
| | | Mushrooms |
| | | Sweet peppers |
| | | Beansprouts |
| | | Green salad, lettuce, cucumber, celery |
| | | Mixed vegetables (frozen or tinned) |
| | | Watercress |
| | | Tomatoes |
| | | Sweetcorn |
| | | Beetroot, radishes |
| | | Coleslaw |
| | | Avocado |
| | | Baked beans |
| | | Dried lentils, beans, peas |
| | | Tofu, soya meat, TVP, vegeburger |

Appendix A

**Adolescence (12-13 years old)**

Adolescent's food intake in using a 24h recall (INTAKE24) during adolescence – (Foster et al., 2014)

| | | |
|---|---|---|
| Healthy Eating | Canned/stewed fruit | |
| | Baked beans | |
| | Peas<br>frozen, fresh, canned, dried & split. | |
| | Other vegetables (excluding potato): carrots, green beans, pulses, cabbage, tomato base sauce, mushrooms, sweetcorn, stir fried vegetables, green salad | |
| | Fresh fruit | |
| | Dried fruit | |
| | Pulses and lentils | |
| Unhealthy Eating | Breakfast alternatives | nutrigrain bar, pop tart, breakfast cereal bars |
| | Sweet biscuits | excludes full coated biscuits |
| | Savoury biscuits and baked goods | e.g. crackers, oatcakes, water biscuits, cheddars, cheese/savoury scones |
| | Cakes | sweet buns, sweet pastries, fruit scones and custard tart (sweet but not savoury based items). |
| | Non-potato snacks | e.g. pretzels, tortilla crisps |
| | Sweets (non-chocolate) | toffee, boiled sweets, gums/jellies, mints, liquorice, raw jelly, popcorn. |
| | Chocolate | includes all plain, milk & white chocolate bars & coated bars e.g. caramels & wafers and full coated chocolate biscuits. |
| | Ice cream, ice cream desserts and lollies | |
| | Chocolate covered ice cream bars | |
| | Potato based crisps – low fat | |
| | Potato based crisps – full fat | |

Appendix B

*Child's food intake in using food diary recoding 4 days (FAST) – (Adamson et al., 2003)*

Dear Parent or Guardian

6-8y

This diary is to record everything your child eats and drinks over the next 4 days.

- **At school** - observers will record what your child eats and drinks.
- **At home** - we need you to record EVERYTHING your child eats and drinks.

Please remember that your child should eat and drink as they usually do.
All the information we collect is confidential and
**there are no right and wrong answers.**

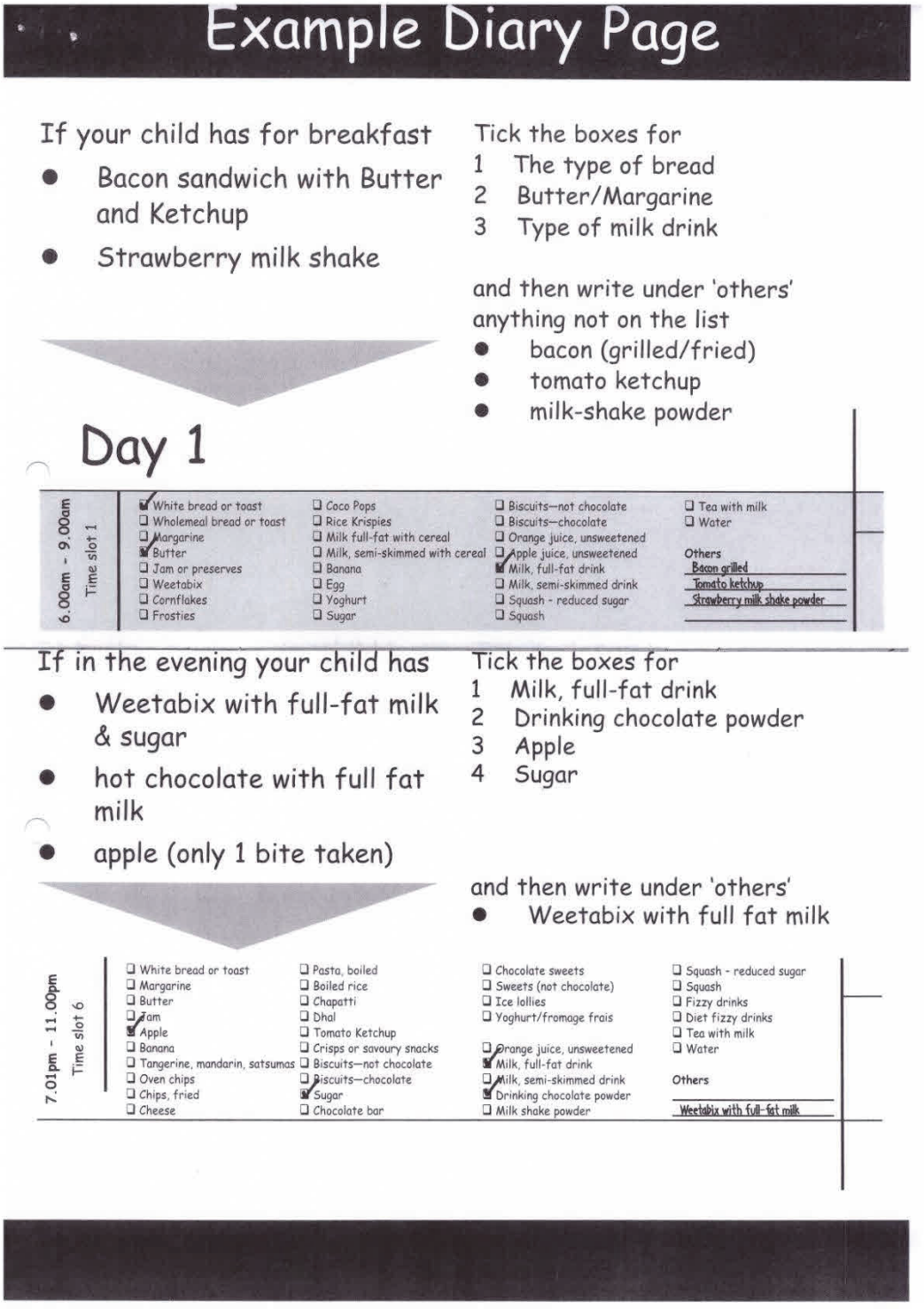

We just need to know what your child eats, not how much. For example, if your child eats white bread for breakfast, tick the box for white bread whether they eat only one mouthful or several slices.

An example of how to fill in the diary is given on the next page
Each day is divided up into 6 time slots

| | |
|---|---|
| 1 | 6.00 am - 9.00 am |
| 2 | 9.01 am - 11.00 am |
| 3 | 11.01 am - 2.00 pm |
| 4 | 2.01 pm - 4.00 pm |
| 5 | 4.01 pm - 7.00 pm |
| 6 | 7.01 pm - 11.00 pm |

Some of the most common foods eaten by children at each of these times are listed. If what your child has eaten is listed then simply tick the correct box. If an item is not listed then write it down in the 'other' box (stating the brand/supermarket e.g Asda/Netto own brand).

*Child's food intake (cont.)*



# Example Diary Page

If your child has for breakfast

- Bacon sandwich with Butter and Ketchup
- Strawberry milk shake

Tick the boxes for
1 The type of bread
2 Butter/Margarine
3 Type of milk drink

and then write under 'others' anything not on the list
- bacon (grilled/fried)
- tomato ketchup
- milk-shake powder

## Day 1

6.00am - 9.00am
Time slot 1

| | | | |
|---|---|---|---|
| ☑ White bread or toast | ☐ Coco Pops | ☐ Biscuits—not chocolate | ☐ Tea with milk |
| ☐ Wholemeal bread or toast | ☐ Rice Krispies | ☐ Biscuits—chocolate | ☐ Water |
| ☐ Margarine | ☐ Milk full-fat with cereal | ☐ Orange juice, unsweetened | |
| ☑ Butter | ☐ Milk, semi-skimmed with cereal | ☑ Apple juice, unsweetened | Others |
| ☐ Jam or preserves | ☐ Banana | ☑ Milk, full-fat drink | Bacon grilled |
| ☐ Weetabix | ☐ Egg | ☐ Milk, semi-skimmed drink | Tomato ketchup |
| ☐ Cornflakes | ☐ Yoghurt | ☐ Squash - reduced sugar | Strawberry milk shake powder |
| ☐ Frosties | ☐ Sugar | ☐ Squash | |

If in the evening your child has
- Weetabix with full-fat milk & sugar
- hot chocolate with full fat milk
- apple (only 1 bite taken)

Tick the boxes for
1 Milk, full-fat drink
2 Drinking chocolate powder
3 Apple
4 Sugar

and then write under 'others'
- Weetabix with full fat milk

7.01pm - 11.00pm
Time slot 6

| | | | |
|---|---|---|---|
| ☐ White bread or toast | ☐ Pasta, boiled | ☐ Chocolate sweets | ☐ Squash - reduced sugar |
| ☐ Margarine | ☐ Boiled rice | ☐ Sweets (not chocolate) | ☐ Squash |
| ☐ Butter | ☐ Chapatti | ☐ Ice lollies | ☐ Fizzy drinks |
| ☐ Jam | ☐ Dhal | ☐ Yoghurt/fromage frais | ☐ Diet fizzy drinks |
| ☑ Apple | ☐ Tomato Ketchup | | ☐ Tea with milk |
| ☐ Banana | ☐ Crisps or savoury snacks | ☐ Orange juice, unsweetened | ☐ Water |
| ☐ Tangerine, mandarin, satsumas | ☐ Biscuits—not chocolate | ☑ Milk, full-fat drink | |
| ☐ Oven chips | ☐ Biscuits—chocolate | ☐ Milk, semi-skimmed drink | Others |
| ☐ Chips, fried | ☑ Sugar | ☑ Drinking chocolate powder | |
| ☐ Cheese | ☐ Chocolate bar | ☐ Milk shake powder | Weetabix with full-fat milk |

*Child's food intake (cont.)*

# Day 1

**6.00am - 9.00am** Time slot 1

| | | | |
|---|---|---|---|
| ❑ White bread or toast | ❑ Coco Pops | ❑ Biscuits—not chocolate | ❑ Squash |
| ❑ Wholemeal bread or toast | ❑ Rice Krispies | ❑ Biscuits—chocolate | ❑ Tea with milk |
| ❑ Margarine | ❑ Milk full-fat with cereal | | ❑ Water |
| ❑ Butter | ❑ Milk, semi-skimmed with cereal | ❑ Orange juice, unsweetened | |
| ❑ Jam or preserves | ❑ Banana | ❑ Apple juice, unsweetened | Others |
| ❑ Weetabix | ❑ Egg | ❑ Milk, full-fat drink | _____ |
| ❑ Cornflakes | ❑ Yoghurt | ❑ Milk, semi-skimmed drink | _____ |
| ❑ Frosties | ❑ Sugar | ❑ Squash—reduced sugar | _____ |

**9.01am - 11.00am** Time slot 2

| | | | |
|---|---|---|---|
| ❑ White bread or toast | ○❑ Tangerine, mandarin, satsuma | ❑ Orange juice, unsweetened | ❑ Water |
| ❑ Wholemeal bread or toast | ❑ Crisps or savoury snacks | ○❑ Apple juice, unsweetened | |
| ❑ Margarine | ❑ Biscuits—not chocolate | ○❑ Milk, full-fat drink | |
| ❑ Butter | ❑ Biscuits—chocolate | ❑ Milk, semi-skimmed drink | Others |
| ❑ Jam or preserves | ❑ Chocolate bar | ❑ Squash—reduced sugar | _____ |
| ○❑ Apple | ❑ Chocolate sweets | ❑ Squash | _____ |
| ○❑ Banana | ❑ Sweets (not chocolate) | ❑ Fizzy drink | _____ |
| ○❑ Pear | | ❑ Diet fizzy drink | _____ |

**11.01am - 2.00pm** Time slot 3

| | | | |
|---|---|---|---|
| ❑ White bread or toast | ❑ Oven chips | ❑ Grapes | ❑ Fizzy drink |
| ❑ Wholemeal bread or toast | ❑ Chips—fried | ❑ Strawberries | ❑ Diet fizzy drink |
| ❑ Margarine | ❑ Potatoes—other | ❑ Raisins | ❑ Water |
| ❑ Butter | ❑ Peas | ❑ Biscuits—not chocolate | |
| ❑ Cheese | ❑ Sweetcorn | ❑ Biscuits—chocolate | Others |
| ❑ Cheese spread / triangle | ❑ Carrots | ❑ Yoghurt / fromage frais | _____ |
| ❑ Baked beans | ❑ Cucumber | ❑ Cake or sweet pastry | _____ |
| ❑ Fish fingers | ❑ Tomato | ❑ Custard | _____ |
| ❑ Ham | ❑ Crisps or savoury snacks | ❑ Chocolate bar | _____ |
| ❑ Chicken or turkey (not nuggets) | ❑ Ketchup | ❑ Sweets (not chocolate) | _____ |
| ❑ Sausage roll | ❑ Gravy | | _____ |
| ❑ Tuna, tinned | ❑ Apple | ❑ Orange juice, unsweetened | _____ |
| ❑ Eggs, boiled | ❑ Banana | ❑ Squash—reduced sugar | _____ |
| ❑ Pasta, tinned, in tomato sauce | ❑ Tangerine, mandarin, satsuma | ❑ Squash | _____ |

**2.01pm - 4.00pm** Time slot 4

| | | | |
|---|---|---|---|
| ❑ White bread or toast | ❑ Biscuits—not chocolate | ❑ Yoghurt / Fromage frais | ❑ Diet fizzy drink |
| ❑ Margarine | ❑ Biscuits—chocolate | | ❑ Water |
| ❑ Butter | ❑ Chocolate bar | ❑ Orange juice, unsweetened | |
| ○❑ Apple | ❑ Chocolate sweets | ❑ Milk, full-fat drink | Others |
| ○❑ Banana | ❑ Sweets (not chocolate) | ❑ Milk, semi-skimmed drink | _____ |
| ○❑ Pear | ❑ Ice lolly | ❑ Squash—reduced sugar | _____ |
| ○❑ Tangerine, mandarin, satsuma | ❑ Cheese | ❑ Squash | _____ |
| ❑ Crisps or savoury snacks | ❑ Tomato ketchup | ❑ Fizzy drink | _____ |

**4.01pm - 7.00pm** Time slot 5

| | | | |
|---|---|---|---|
| ❑ White bread or toast | ❑ Tomato | ❑ Gravy | ❑ Milk, semi-skimmed drink |
| ❑ Margarine | ❑ Broccoli | ❑ Tomato ketchup | ❑ Squash—reduced sugar |
| ❑ Butter | ❑ Sausages | ❑ Yoghurt / fromage frais | ❑ Squash |
| ❑ Apple | ❑ Pasta, boiled | ❑ Crisps or savoury snacks | ❑ Fizzy drink |
| ❑ Banana | ❑ Pasta, tinned in tomato sauce | ❑ Biscuits—not chocolate | ❑ Diet fizzy drink |
| ❑ Grapes | ❑ Fish fingers | ❑ Biscuits—chocolate | ❑ Tea with milk |
| ❑ Strawberries | ❑ Chicken or turkey nuggets | ❑ Cake or sweet pastry | ❑ Water |
| ❑ Oven chips | ❑ Chicken or turkey (not nuggets) | ❑ Chocolate bar | |
| ❑ Chips—fried | ❑ Pizza | ❑ Chocolate sweets | Others |
| ❑ Boiled potatoes | ❑ Baked beans | ❑ Sweets (not chocolate) | _____ |
| ❑ Potatoes—other | ❑ Cheese | ❑ Ice cream | _____ |
| ❑ Carrots | ❑ Boiled rice | | _____ |
| ❑ Peas | ❑ Ham | ❑ Orange juice, unsweetened | _____ |
| ❑ Sweetcorn | ❑ Chapatti | ❑ Apple juice, unsweetened | _____ |
| ❑ Cucumber | ❑ Dhal | ❑ Milk, full-fat drink | _____ |

**7.01pm - 11.00pm** Time slot 6

| | | | |
|---|---|---|---|
| ❑ White bread or toast | ❑ Pasta, boiled | ❑ Chocolate sweets | ❑ Squash—reduced sugar |
| ❑ Margarine | ❑ Boiled rice | ❑ Sweets (not chocolate) | ❑ Squash |
| ❑ Butter | ❑ Chapatti | ❑ Ice lollies | ❑ Fizzy drinks |
| ❑ Jam | ❑ Dhal | ❑ Yoghurt / fromage frais | ❑ Diet fizzy drinks |
| ❑ Apple | ❑ Tomato Ketchup | | ❑ Tea with milk |
| ❑ Banana | ❑ Crisps or savoury snacks | ❑ Orange juice, unsweetened | ❑ Water |
| ❑ Tangerine, mandarin, satsuma | ❑ Biscuits—not chocolate | ❑ Milk, full-fat drink | |
| ❑ Oven chips | ❑ Biscuits—chocolate | ❑ Milk, semi-skimmed drink | Others |
| ❑ Chips—fried | ❑ Sugar | ❑ Drinking chocolate powder | _____ |
| ❑ Cheese | ❑ Chocolate bar | ❑ Milk shake powder | _____ |
| | | | _____ |
| | | | _____ |
| | | | _____ |

*Child's food intake (cont.)*

# Day 2

**6.00am - 9.00am** Time slot 1

- ❑ White bread or toast
- ❑ Wholemeal bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Jam or preserves
- ❑ Weetabix
- ❑ Cornflakes
- ❑ Frosties
- ❑ Coco Pops
- ❑ Rice Krispies
- ❑ Milk full-fat with cereal
- ❑ Milk, semi-skimmed with cereal
- ❑ Banana
- ❑ Egg
- ❑ Yoghurt
- ❑ Sugar
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Orange juice, unsweetened
- ❑ Apple juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Tea with milk
- ❑ Water

Others

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**9.01am - 11.00am** Time slot 2

- ❑ White bread or toast
- ❑ Wholemeal bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Jam or preserves
- ○❑ Apple
- ○❑ Banana
- ○❑ Pear
- ○❑ Tangerine, mandarin, satsuma
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Orange juice, unsweetened
- ○❑ Apple juice, unsweetened
- ○❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Water

Others

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**11.01am - 2.00pm** Time slot 3

- ❑ White bread or toast
- ❑ Wholemeal bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Cheese
- ❑ Cheese spread / triangle
- ❑ Baked beans
- ❑ Fish fingers
- ❑ Ham
- ❑ Chicken or turkey (not nuggets)
- ❑ Sausage roll
- ❑ Tuna, tinned
- ❑ Eggs, boiled
- ❑ Pasta, tinned, in tomato sauce
- ❑ Oven chips
- ❑ Chips—fried
- ❑ Potatoes—other
- ❑ Peas
- ❑ Sweetcorn
- ❑ Carrots
- ❑ Cucumber
- ❑ Tomato
- ❑ Crisps or savoury snacks
- ❑ Ketchup
- ❑ Gravy
- ❑ Apple
- ❑ Banana
- ❑ Tangerine, mandarin, satsuma
- ❑ Grapes
- ❑ Strawberries
- ❑ Raisins
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Yoghurt / fromage frais
- ❑ Cake or sweet pastry
- ❑ Custard
- ❑ Chocolate bar
- ❑ Sweets (not chocolate)
- ❑ Orange juice, unsweetened
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Water

Others

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**2.01pm - 4.00pm** Time slot 4

- ❑ White bread or toast
- ❑ Margarine
- ❑ Butter
- ○❑ Apple
- ○❑ Banana
- ○❑ Pear
- ○❑ Tangerine, mandarin, satsuma
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Ice lolly
- ❑ Cheese
- ❑ Tomato ketchup
- ❑ Yoghurt / Fromage frais
- ❑ Orange juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Water

Others

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**4.01pm - 7.00pm** Time slot 5

- ❑ White bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Apple
- ❑ Banana
- ❑ Grapes
- ❑ Strawberries
- ❑ Oven chips
- ❑ Chips—fried
- ❑ Boiled potatoes
- ❑ Potatoes—other
- ❑ Carrots
- ❑ Peas
- ❑ Sweetcorn
- ❑ Cucumber
- ❑ Tomato
- ❑ Broccoli
- ❑ Sausages
- ❑ Pasta, boiled
- ❑ Pasta, tinned in tomato sauce
- ❑ Fish fingers
- ❑ Chicken or turkey nuggets
- ❑ Chicken or turkey (not nuggets)
- ❑ Pizza
- ❑ Baked beans
- ❑ Cheese
- ❑ Boiled rice
- ❑ Ham
- ❑ Chapatti
- ❑ Dhal
- ❑ Gravy
- ❑ Tomato ketchup
- ❑ Yoghurt / fromage frais
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Cake or sweet pastry
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Ice cream
- ❑ Orange juice, unsweetened
- ❑ Apple juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Tea with milk
- ❑ Water

Others

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**7.01pm - 11.00pm** Time slot 6

- ❑ White bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Jam
- ❑ Apple
- ❑ Banana
- ❑ Tangerine, mandarin, satsuma
- ❑ Oven chips
- ❑ Chips—fried
- ❑ Cheese
- ❑ Pasta, boiled
- ❑ Boiled rice
- ❑ Chapatti
- ❑ Dhal
- ❑ Tomato Ketchup
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Sugar
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Ice lollies
- ❑ Yoghurt / fromage frais
- ❑ Orange juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Drinking chocolate powder
- ❑ Milk shake powder
- ❑ Squash - reduced sugar
- ❑ Squash
- ❑ Fizzy drinks
- ❑ Diet fizzy drinks
- ❑ Tea with milk
- ❑ Water

Others

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Appendix B

*Child's food intake (cont.)*

# Day 3

**6.00am - 9.00am Time slot 1**

- ❑ White bread or toast
- ❑ Wholemeal bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Jam or preserves
- ❑ Weetabix
- ❑ Cornflakes
- ❑ Frosties
- ❑ Coco Pops
- ❑ Rice Krispies
- ❑ Milk full-fat with cereal
- ❑ Milk, semi-skimmed with cereal
- ❑ Banana
- ❑ Egg
- ❑ Yoghurt
- ❑ Sugar
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Orange juice, unsweetened
- ❑ Apple juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Tea with milk
- ❑ Water

Others

**9.01am - 11.00am Time slot 2**

- ❑ White bread or toast
- ❑ Wholemeal bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Jam or preserves
- ○❑ Apple
- ○❑ Banana
- ○❑ Pear
- ○❑ Tangerine, mandarin, satsuma
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Orange juice, unsweetened
- ○❑ Apple juice, unsweetened
- ○❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Water

Others

**11.01am - 2.00pm Time slot 3**

- ❑ White bread or toast
- ❑ Wholemeal bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Cheese
- ❑ Cheese spread / triangle
- ❑ Baked beans
- ❑ Fish fingers
- ❑ Ham
- ❑ Chicken or turkey (not nuggets)
- ❑ Sausage roll
- ❑ Tuna, tinned
- ❑ Eggs, boiled
- ❑ Pasta, tinned, in tomato sauce
- ❑ Oven chips
- ❑ Chips—fried
- ❑ Potatoes—other
- ❑ Peas
- ❑ Sweetcorn
- ❑ Carrots
- ❑ Cucumber
- ❑ Tomato
- ❑ Crisps or savoury snacks
- ❑ Ketchup
- ❑ Gravy
- ❑ Apple
- ❑ Banana
- ❑ Tangerine, mandarin, satsuma
- ❑ Grapes
- ❑ Strawberries
- ❑ Raisins
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Yoghurt / fromage frais
- ❑ Cake or sweet pastry
- ❑ Custard
- ❑ Chocolate bar
- ❑ Sweets (not chocolate)
- ❑ Orange juice, unsweetened
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Water

Others

**2.01pm - 4.00pm Time slot 4**

- ❑ White bread or toast
- ❑ Margarine
- ❑ Butter
- ○❑ Apple
- ○❑ Banana
- ○❑ Pear
- ○❑ Tangerine, mandarin, satsuma
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Ice lolly
- ❑ Cheese
- ❑ Tomato ketchup
- ❑ Yoghurt / Fromage frais
- ❑ Orange juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Water

Others

**4.01pm - 7.00pm Time slot 5**

- ❑ White bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Apple
- ❑ Banana
- ❑ Grapes
- ❑ Strawberries
- ❑ Oven chips
- ❑ Chips—fried
- ❑ Boiled potatoes
- ❑ Potatoes—other
- ❑ Carrots
- ❑ Peas
- ❑ Sweetcorn
- ❑ Cucumber
- ❑ Tomato
- ❑ Broccoli
- ❑ Sausages
- ❑ Pasta, boiled
- ❑ Pasta, tinned in tomato sauce
- ❑ Fish fingers
- ❑ Chicken or turkey nuggets
- ❑ Chicken or turkey (not nuggets)
- ❑ Pizza
- ❑ Baked beans
- ❑ Cheese
- ❑ Boiled rice
- ❑ Ham
- ❑ Chapatti
- ❑ Dhal
- ❑ Gravy
- ❑ Tomato ketchup
- ❑ Yoghurt / fromage frais
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Cake or sweet pastry
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Ice cream
- ❑ Orange juice, unsweetened
- ❑ Apple juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Tea with milk
- ❑ Water

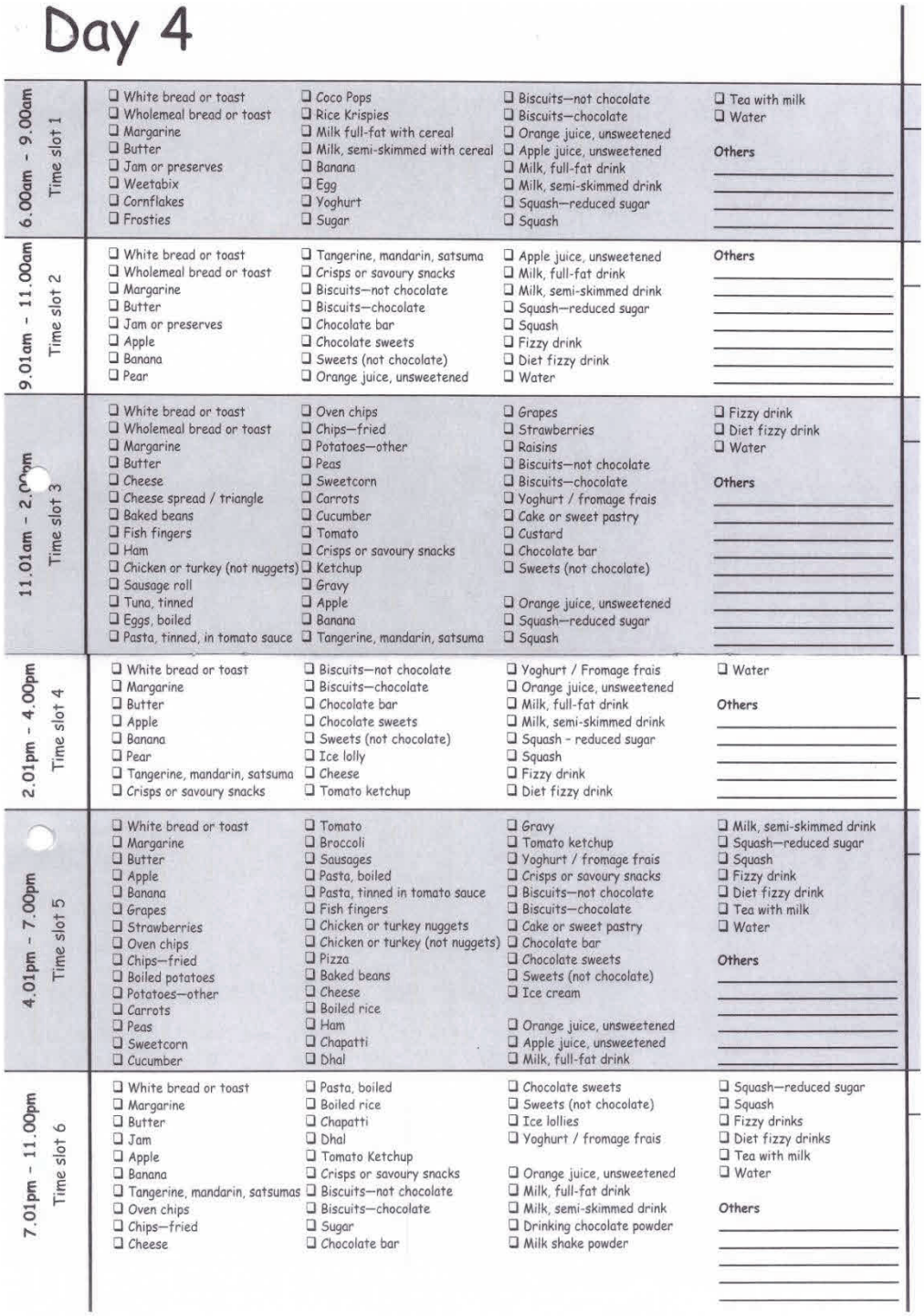
Others

**7.01pm - 11.00pm Time slot 6**

- ❑ White bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Jam
- ❑ Apple
- ❑ Banana
- ❑ Tangerine, mandarin, satsumas
- ❑ Oven chips
- ❑ Chips—fried
- ❑ Cheese
- ❑ Pasta, boiled
- ❑ Boiled rice
- ❑ Chapatti
- ❑ Dhal
- ❑ Tomato Ketchup
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Sugar
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Ice lollies
- ❑ Yoghurt / fromage frais
- ❑ Orange juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Drinking chocolate powder
- ❑ Milk shake powder
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drinks
- ❑ Diet fizzy drinks
- ❑ Tea with milk
- ❑ Water

Others

*Child's food intake (cont.)*



# Day 4

**6.00am - 9.00am — Time slot 1**

- ❑ White bread or toast
- ❑ Wholemeal bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Jam or preserves
- ❑ Weetabix
- ❑ Cornflakes
- ❑ Frosties
- ❑ Coco Pops
- ❑ Rice Krispies
- ❑ Milk full-fat with cereal
- ❑ Milk, semi-skimmed with cereal
- ❑ Banana
- ❑ Egg
- ❑ Yoghurt
- ❑ Sugar
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Orange juice, unsweetened
- ❑ Apple juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Tea with milk
- ❑ Water

Others

**9.01am - 11.00am — Time slot 2**

- ❑ White bread or toast
- ❑ Wholemeal bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Jam or preserves
- ❑ Apple
- ❑ Banana
- ❑ Pear
- ❑ Tangerine, mandarin, satsuma
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Orange juice, unsweetened
- ❑ Apple juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Water

Others

**11.01am - 2.00pm — Time slot 3**

- ❑ White bread or toast
- ❑ Wholemeal bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Cheese
- ❑ Cheese spread / triangle
- ❑ Baked beans
- ❑ Fish fingers
- ❑ Ham
- ❑ Chicken or turkey (not nuggets)
- ❑ Sausage roll
- ❑ Tuna, tinned
- ❑ Eggs, boiled
- ❑ Pasta, tinned, in tomato sauce
- ❑ Oven chips
- ❑ Chips—fried
- ❑ Potatoes—other
- ❑ Peas
- ❑ Sweetcorn
- ❑ Carrots
- ❑ Cucumber
- ❑ Tomato
- ❑ Crisps or savoury snacks
- ❑ Ketchup
- ❑ Gravy
- ❑ Apple
- ❑ Banana
- ❑ Tangerine, mandarin, satsuma
- ❑ Grapes
- ❑ Strawberries
- ❑ Raisins
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Yoghurt / fromage frais
- ❑ Cake or sweet pastry
- ❑ Custard
- ❑ Chocolate bar
- ❑ Sweets (not chocolate)
- ❑ Orange juice, unsweetened
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Water

Others

**2.01pm - 4.00pm — Time slot 4**

- ❑ White bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Apple
- ❑ Banana
- ❑ Pear
- ❑ Tangerine, mandarin, satsuma
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Ice lolly
- ❑ Cheese
- ❑ Tomato ketchup
- ❑ Yoghurt / Fromage frais
- ❑ Orange juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash - reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Water

Others

**4.01pm - 7.00pm — Time slot 5**

- ❑ White bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Apple
- ❑ Banana
- ❑ Grapes
- ❑ Strawberries
- ❑ Oven chips
- ❑ Chips—fried
- ❑ Boiled potatoes
- ❑ Potatoes—other
- ❑ Carrots
- ❑ Peas
- ❑ Sweetcorn
- ❑ Cucumber
- ❑ Tomato
- ❑ Broccoli
- ❑ Sausages
- ❑ Pasta, boiled
- ❑ Pasta, tinned in tomato sauce
- ❑ Fish fingers
- ❑ Chicken or turkey nuggets
- ❑ Chicken or turkey (not nuggets)
- ❑ Pizza
- ❑ Baked beans
- ❑ Cheese
- ❑ Boiled rice
- ❑ Ham
- ❑ Chapatti
- ❑ Dhal
- ❑ Gravy
- ❑ Tomato ketchup
- ❑ Yoghurt / fromage frais
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Cake or sweet pastry
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Ice cream
- ❑ Orange juice, unsweetened
- ❑ Apple juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drink
- ❑ Diet fizzy drink
- ❑ Tea with milk
- ❑ Water

Others

**7.01pm - 11.00pm — Time slot 6**

- ❑ White bread or toast
- ❑ Margarine
- ❑ Butter
- ❑ Jam
- ❑ Apple
- ❑ Banana
- ❑ Tangerine, mandarin, satsumas
- ❑ Oven chips
- ❑ Chips—fried
- ❑ Cheese
- ❑ Pasta, boiled
- ❑ Boiled rice
- ❑ Chapatti
- ❑ Dhal
- ❑ Tomato Ketchup
- ❑ Crisps or savoury snacks
- ❑ Biscuits—not chocolate
- ❑ Biscuits—chocolate
- ❑ Sugar
- ❑ Chocolate bar
- ❑ Chocolate sweets
- ❑ Sweets (not chocolate)
- ❑ Ice lollies
- ❑ Yoghurt / fromage frais
- ❑ Orange juice, unsweetened
- ❑ Milk, full-fat drink
- ❑ Milk, semi-skimmed drink
- ❑ Drinking chocolate powder
- ❑ Milk shake powder
- ❑ Squash—reduced sugar
- ❑ Squash
- ❑ Fizzy drinks
- ❑ Diet fizzy drinks
- ❑ Tea with milk
- ❑ Water

Others

*Child's food intake (cont.)*

## Notes

## Thank you

Gateshead Millennium Study

Thank you for helping us to complete this diary.

Gateshead Millennium Study

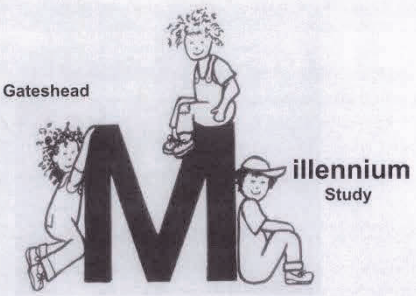
Appendix B

*Parents' food intake in using food frequency questionnaire – (Bingham et al., 1997)*

(4) 2006 Parent food frequency (parent)

ID No.

6-8y




# Dietary Questionnaire

Please turn over and read the instructions for answering questions before completing the questionnaire.

When you have finished, please return the booklet in the envelope provided and post it back to us as soon as possible. No stamp is needed.

If you need any help filling in the questionnaire, please contact -

Gateshead Millennium Study
Human Nutrition Research Centre
Newcastle University
M1.151 Leech Building
Framlington Place
Newcastle upon Tyne
Tel: 0191 2228896

*Parents' food intake (cont.)*

(4) 2006 Parent food frequency (parent)

## About the food you eat

The following questions are about the food you usually eat and how often you eat certain foods. Please read the following instructions before answering the questions.

For each food there is an amount shown, either a "medium serving" or a common household unit such as a slice or teaspoon. Please put a tick (✓) in the box to indicate how often, **on average**, you have eaten the specified amount of each food **during the past year.**

**EXAMPLE:**

For white bread the amount is one slice, so if you ate 4 or 5 slices a day, you should put a tick in the column headed "4-5 per day".

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **BREAD & SAVOURY BISCUITS (one slice or biscuit)** | Never or less than once/month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| White bread and rolls | | | | | | | | ✓ | |

**EXAMPLE:**

For chips, the amount is a "medium serving", so if you had a helping of chips twice a week you should put a tick in the column headed "2-4 per week".

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **POTATOES, RICE & PASTA (medium serving)** | Never or less than once/month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| Chips | | | | ✓ | | | | | |

*Parents' food intake (cont.)*

(4) 2006 Parent food frequency (parent)

Please put a tick (✓) in each box to indicate how often, **on average**, you have eaten each food **during the past year.**

Please estimate your average food use as best you can, and please answer every question - do not leave **ANY** lines blank. **Please put a tick (✓) on every line.**

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1. MEAT & FISH** ***(medium serving)*** | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| Beef: roast, steak, mince, stew casserole, curry or bolognese | | | | | | | | | |
| Beefburgers | | | | | | | | | |
| Pork: roast, chops, stew, slice or curry | | | | | | | | | |
| Lamb: roast, chops, stew or curry | | | | | | | | | |
| Chicken, turkey or other poultry: including fried, casseroles or curry | | | | | | | | | |
| Bacon | | | | | | | | | |
| Ham | | | | | | | | | |
| Corned beef, Spam, luncheon meats | | | | | | | | | |
| Sausages | | | | | | | | | |
| Savoury pies, e.g. meat pie, pork pie, pasties, steak & kidney pie, sausage rolls, scotch egg | | | | | | | | | |
| | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |

**Please check that you have a tick (✓) on EVERY line**

Appendix B

*Parents' food intake (cont.)*

(4) 2006 Parent food frequency (parent)

*PLEASE PUT A TICK (✓) ON EVERY LINE.*

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **1. MEAT & FISH, (continued)** ***(medium serving)*** | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| Liver, liver pate, liver sausage | | | | | | | | | |
| Fried fish in batter, as in fish and chips | | | | | | | | | |
| Fish fingers, fish cakes | | | | | | | | | |
| Other white fish, fresh or frozen, e.g. cod, haddock, plaice, sole, halibut | | | | | | | | | |
| Oily fish, fresh or canned, e.g. mackerel, kippers, tuna, salmon, sardines, herring | | | | | | | | | |
| Shellfish, e.g. crab, prawns, mussels | | | | | | | | | |
| **2. BREAD & SAVOURY BISCUITS** ***(one slice or biscuit)*** | | | | | | | | | |
| White bread and rolls | | | | | | | | | |
| Scones, teacakes, crumpets, muffins or croissants | | | | | | | | | |
| Brown bread and rolls | | | | | | | | | |
| Wholemeal bread and rolls | | | | | | | | | |
| Cream crackers, cheese biscuits | | | | | | | | | |
| Pitta bread, naan bread, chapati | | | | | | | | | |
| Garlic bread | | | | | | | | | |
| | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |

**Please check that you have a tick (✓) on EVERY line**

Appendix B

*Parents' food intake (cont.)*

(4) 2006 Parent food frequency (parent)

PLEASE PUT A TICK (✓) ON EVERY LINE.

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **4. POTATOES, RICE & PASTA (continued)** *(medium serving)* | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| Super noodles, pot noodles, pot savouries | | | | | | | | | |
| Wholemeal pasta | | | | | | | | | |
| Lasagne, moussaka, cannelloni | | | | | | | | | |
| Pizza | | | | | | | | | |
| **5. DAIRY PRODUCTS & FATS** | | | | | | | | | |
| Single or sour cream *(tablespoon)* | | | | | | | | | |
| Double or clotted cream *(tablespoon)* | | | | | | | | | |
| Low fat yoghurt, fromage frais *(125g carton)* | | | | | | | | | |
| Full fat or Greek yoghurt *(125g carton)* | | | | | | | | | |
| Dairy desserts *(125g carton)*, e.g. mousse | | | | | | | | | |
| Cheese, e.g. Cheddar, Brie, Edam *(medium serving)* | | | | | | | | | |
| Cottage cheese, low fat soft cheese *(medium serving)* | | | | | | | | | |
| Eggs as boiled, fried, scrambled, omelette etc. *(one)* | | | | | | | | | |
| Quiche *(medium serving)* | | | | | | | | | |
| | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |

**Please check that you have a tick (✓) on EVERY line**

Appendix B

*Parents' food intake (cont.)*

(4) 2006 Parent food frequency (parent)

PLEASE PUT A TICK (✓) ON EVERY LINE.

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **5.(b) The following on bread or vegetables *(teaspoon)*** | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| Butter | | | | | | | | | |
| Block margarine, e.g. Stork, Krona | | | | | | | | | |
| Polyunsaturated margarine, e.g. Flora sunflower | | | | | | | | | |
| Other soft margarine, dairy spreads, e.g. Blue Band, Clover | | | | | | | | | |
| Low fat spread, e.g. Gold | | | | | | | | | |
| **6. SWEETS & SNACKS** | | | | | | | | | |
| Sweet biscuits, chocolate, e.g. digestive *(one)* | | | | | | | | | |
| Sweet biscuits, plain, e.g. Nice, ginger *(one)* | | | | | | | | | |
| Cakes e.g. fruit, sponge, sponge pudding *(medium serving)* | | | | | | | | | |
| Sweet buns & pastries e.g. flapjacks, doughnuts, Danish pastries, cream cakes *(medium serving)* | | | | | | | | | |
| Fruit pies, tarts, crumbles *(medium serving)* | | | | | | | | | |
| Milk puddings, e.g. rice, custard, trifle *(medium serving)* | | | | | | | | | |
| Ice cream, choc ices *(one)* | | | | | | | | | |
| Chocolates *(small bar or ¼ pound of chocolates)* | | | | | | | | | |
| Chocolates snack bars e.g. Mars, Crunchie *(one)* | | | | | | | | | |
| | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |

**Please check that you have a tick (✓) on EVERY line**

Appendix B

*Parents' food intake (cont.)*

(4) 2006 Parent food frequency (parent)

PLEASE PUT A TICK (✓) ON EVERY LINE.

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **6. SWEETS & SNACKS (continued)** | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| Sweets, toffees, mints *(one packet)* | | | | | | | | | |
| Sugar added to tea, coffee, cereal *(teaspoon)* | | | | | | | | | |
| Crisps or other packet snacks e.g. Wotsits *(one packet)* | | | | | | | | | |
| Peanuts or other nuts *(one packet)* | | | | | | | | | |
| **7. SOUPS, SAUCES AND SPREADS** | | | | | | | | | |
| Vegetable soups *(bowl)* | | | | | | | | | |
| Meat soups *(bowl)* | | | | | | | | | |
| Sauces, e.g. white sauce, cheese sauce, gravy *(medium serving)* | | | | | | | | | |
| Tomato based sauces e.g. pasta sauces *(medium serving)* | | | | | | | | | |
| Tomato ketchup, brown sauce *(tablespoon)* | | | | | | | | | |
| Relishes e. g. pickles, chutney, mustard *(tablespoon)* | | | | | | | | | |
| Low calorie, low fat salad cream or mayonnaise *(tablespoon)* | | | | | | | | | |
| Salad cream, mayonnaise *(tablespoon)* | | | | | | | | | |
| French dressing *(tablespoon)* | | | | | | | | | |
| | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |

**Please check that you have a tick (✓) on EVERY line**

Appendix B

*Parents' food intake (cont.)*

(4) 2006 Parent food frequency (parent)

*PLEASE PUT A TICK (✓) ON EVERY LINE.*

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **7. SOUPS, SAUCES AND SPREADS (continued)** | Never or less than once/ month | 1-3 per month | Once A Week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| Other salad dressing *(tablespoon)* | | | | | | | | | |
| Marmite, Bovril *(teaspoon)* | | | | | | | | | |
| Jam, marmalade, honey, syrup *(teaspoon)* | | | | | | | | | |
| Peanut butter *(teaspoon)* | | | | | | | | | |
| Chocolate spread, chocolate nut spread *(teaspoon)* | | | | | | | | | |
| Dips e.g. houmous, cheese and chive *(tablespoon)* | | | | | | | | | |
| **8. DRINKS** | | | | | | | | | |
| Tea *(cup)* | | | | | | | | | |
| Coffee, instant or ground *(cup)* | | | | | | | | | |
| Coffee whitener, e.g. Coffee-mate *(teaspoon)* | | | | | | | | | |
| Cocoa, hot chocolate *(cup)* | | | | | | | | | |
| Horlicks, Ovaltine *(cup)* | | | | | | | | | |
| Wine *(glass)* | | | | | | | | | |
| Beer, lager or cider *(half pint)* | | | | | | | | | |
| Port, sherry, vermouth, liqueurs *(glass)* | | | | | | | | | |
| | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |

**Please check that you have a tick (✓) on EVERY line**

*Parents' food intake (cont.)*

(4) 2006 Parent food frequency (parent)

PLEASE PUT A TICK (✓) ON EVERY LINE.

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **8. DRINKS (continued)** | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| Spirits, e.g. gin, brandy, whisky, vodka *(single)* | | | | | | | | | |
| Low calorie or diet fizzy soft drinks *(glass)* | | | | | | | | | |
| Fizzy soft drinks, e.g. Coca cola, lemonade *(glass)* | | | | | | | | | |
| Pure fruit juice (100%) e.g. orange, apple juice *(glass)* | | | | | | | | | |
| Fruit squash or cordial *(glass)* | | | | | | | | | |
| Sugar-free fruit squash or cordial *(glass)* | | | | | | | | | |
| **9. FRUIT *(1 fruit or medium serving)*** *For very seasonal fruits such as strawberries, please estimate your average use when the fruit is in season | | | | | | | | | |
| Apples | | | | | | | | | |
| Pears | | | | | | | | | |
| Oranges, satsumas, mandarins, tangerines, clementines | | | | | | | | | |
| Grapefruit | | | | | | | | | |
| Bananas | | | | | | | | | |
| Grapes | | | | | | | | | |
| Melon | | | | | | | | | |
| *Peaches, plums, apricots, nectarines | | | | | | | | | |
| *Strawberries, raspberries, kiwi fruit | | | | | | | | | |
| | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |

PLEASE PUT A TICK (✓) ON EVERY LINE.

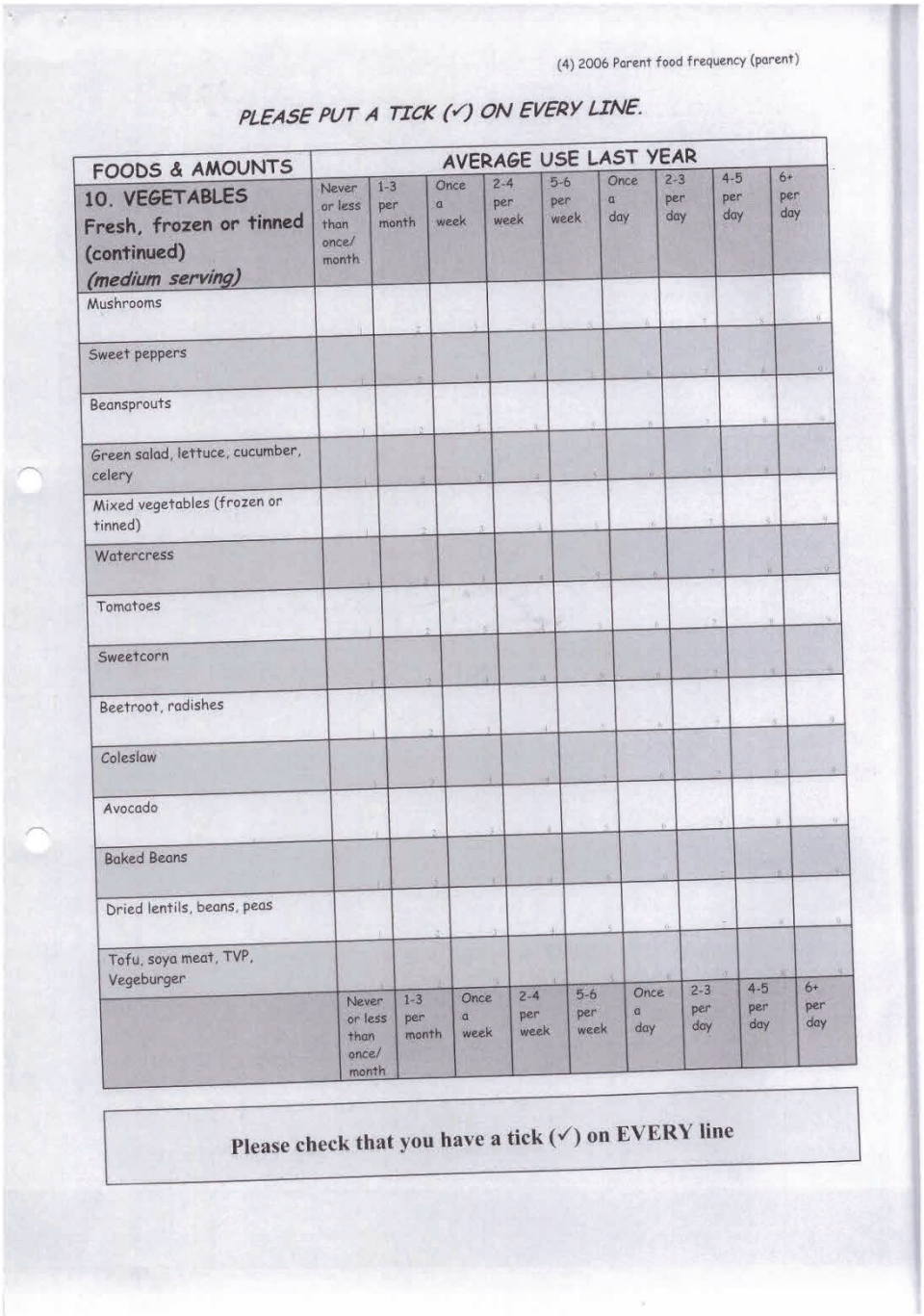
*Parents' food intake (cont.)*

(4) 2006 Parent food frequency (parent)

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **9. FRUIT (continued)** ***(1 fruit or medium serving)*** | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| Tinned fruit | | | | | | | | | |
| Dried fruit, e.g. raisins, prunes, figs | | | | | | | | | |
| **10. VEGETABLES Fresh, frozen or tinned** ***(medium serving)*** | | | | | | | | | |
| Carrots | | | | | | | | | |
| Spinach | | | | | | | | | |
| Broccoli | | | | | | | | | |
| Brussels sprouts | | | | | | | | | |
| Cabbage | | | | | | | | | |
| Peas | | | | | | | | | |
| Green beans, broad beans, runner beans | | | | | | | | | |
| Marrow, courgettes | | | | | | | | | |
| Cauliflower | | | | | | | | | |
| Parsnips, turnips, swedes | | | | | | | | | |
| Leeks | | | | | | | | | |
| Onions | | | | | | | | | |
| Garlic | | | | | | | | | |
| | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |

Appendix B

*Parents' food intake (cont.)*



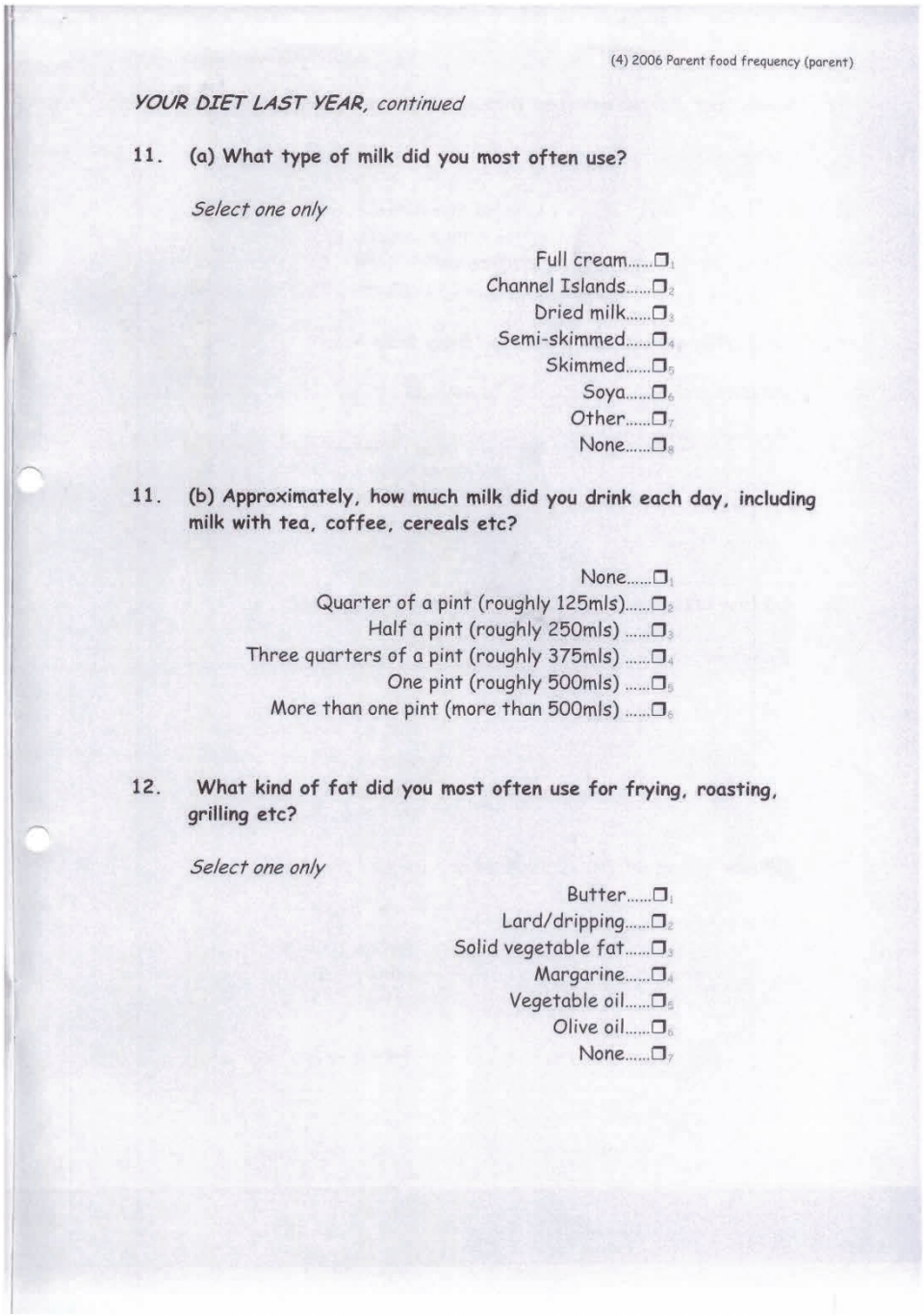
(4) 2006 Parent food frequency (parent)

PLEASE PUT A TICK (✓) ON EVERY LINE.

| FOODS & AMOUNTS | AVERAGE USE LAST YEAR | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **10. VEGETABLES Fresh, frozen or tinned (continued)** ***(medium serving)*** | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |
| Mushrooms | | | | | | | | | |
| Sweet peppers | | | | | | | | | |
| Beansprouts | | | | | | | | | |
| Green salad, lettuce, cucumber, celery | | | | | | | | | |
| Mixed vegetables (frozen or tinned) | | | | | | | | | |
| Watercress | | | | | | | | | |
| Tomatoes | | | | | | | | | |
| Sweetcorn | | | | | | | | | |
| Beetroot, radishes | | | | | | | | | |
| Coleslaw | | | | | | | | | |
| Avocado | | | | | | | | | |
| Baked Beans | | | | | | | | | |
| Dried lentils, beans, peas | | | | | | | | | |
| Tofu, soya meat, TVP, Vegeburger | | | | | | | | | |
| | Never or less than once/ month | 1-3 per month | Once a week | 2-4 per week | 5-6 per week | Once a day | 2-3 per day | 4-5 per day | 6+ per day |

**Please check that you have a tick (✓) on EVERY line**

*Parents' food intake (cont.)*



(4) 2006 Parent food frequency (parent)

*YOUR DIET LAST YEAR, continued*

11. **(a) What type of milk did you most often use?**

*Select one only*

Full cream.....❒1
Channel Islands.....❒2
Dried milk.....❒3
Semi-skimmed.....❒4
Skimmed.....❒5
Soya.....❒6
Other.....❒7
None.....❒8

11. **(b) Approximately, how much milk did you drink each day, including milk with tea, coffee, cereals etc?**

None.....❒1
Quarter of a pint (roughly 125mls).....❒2
Half a pint (roughly 250mls) .....❒3
Three quarters of a pint (roughly 375mls) .....❒4
One pint (roughly 500mls) .....❒5
More than one pint (more than 500mls) .....❒6

12. **What kind of fat did you most often use for frying, roasting, grilling etc?**

*Select one only*

Butter.....❒1
Lard/dripping.....❒2
Solid vegetable fat.....❒3
Margarine.....❒4
Vegetable oil.....❒5
Olive oil.....❒6
None.....❒7

*Parents' food intake (cont.)*

(4) 2006 Parent food frequency (parent)

13. **How often did you eat food that was fried at home?**

*Select one only*

Daily.....❒1
1-3 times a week.....❒2
4-6 times a week.....❒3
Less than once a week.....❒4
Never.....❒5

14. **How often did you eat fried food *away* from home?**

*Select one only*

Daily.....❒1
1-3 times a week.....❒2
4-6 times a week.....❒3
Less than once a week.....❒4
Never.....❒5

15. **(a) How often did you add salt to food while cooking?**

*Select one only*

Always.....❒1
Usually.....❒2
Sometimes.....❒3
Rarely.....❒4
Never.....❒5

15. **(b) How often did you add salt to any food at the table?**

*Select one only*

Always.....❒1
Usually.....❒2
Sometimes.....❒3
Rarely.....❒4
Never.....❒5

*Parents' food intake (cont.)*



**16. Do you follow a special diet?**

*Please tick all that apply.*

No.....☐1
Yes, because of a medical condition/allergy.....☐2
Yes, to lose weight.....☐3
Yes, because of personal beliefs (religion, vegetarian).....☐4
Yes, other.....☐5

**17. Have you taken any of the following during the past year?**

a) Vitamins (e.g. multivitamins, vitamin B, vitamin C, folic acid)

Yes.....☐1
No.....☐2

b) Minerals (e.g. iron, calcium, zinc, magnesium)

Yes.....☐1
No.....☐2

c) Fish oils (e.g. cod liver oil, omega-3)

Yes.....☐1
No.....☐2

d) Other food supplements (e.g. oil of evening primrose, starflower oil, royal jelly, ginseng)

Yes.....☐1
No.....☐2

**THANK YOU FOR COMPLETING THIS QUESTIONNAIRE**

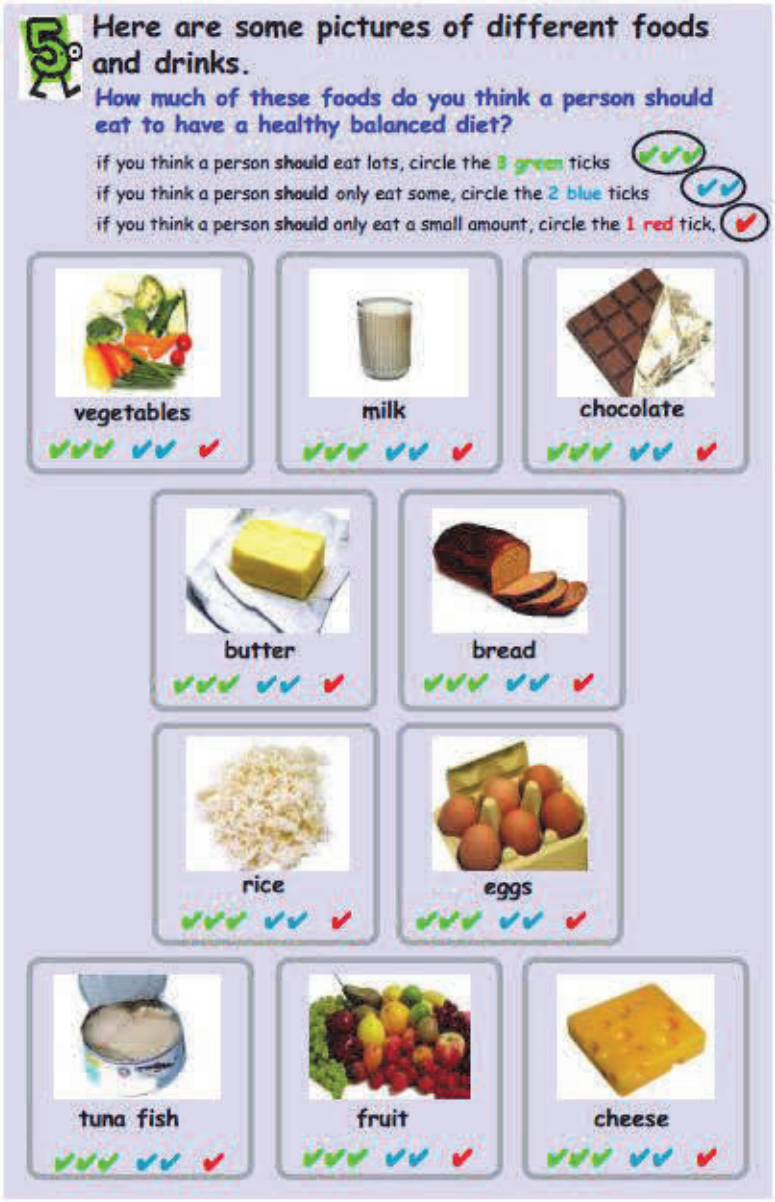
Appendix B

*Knowledge about healthy eating*

– (Schagen et al., 2005)

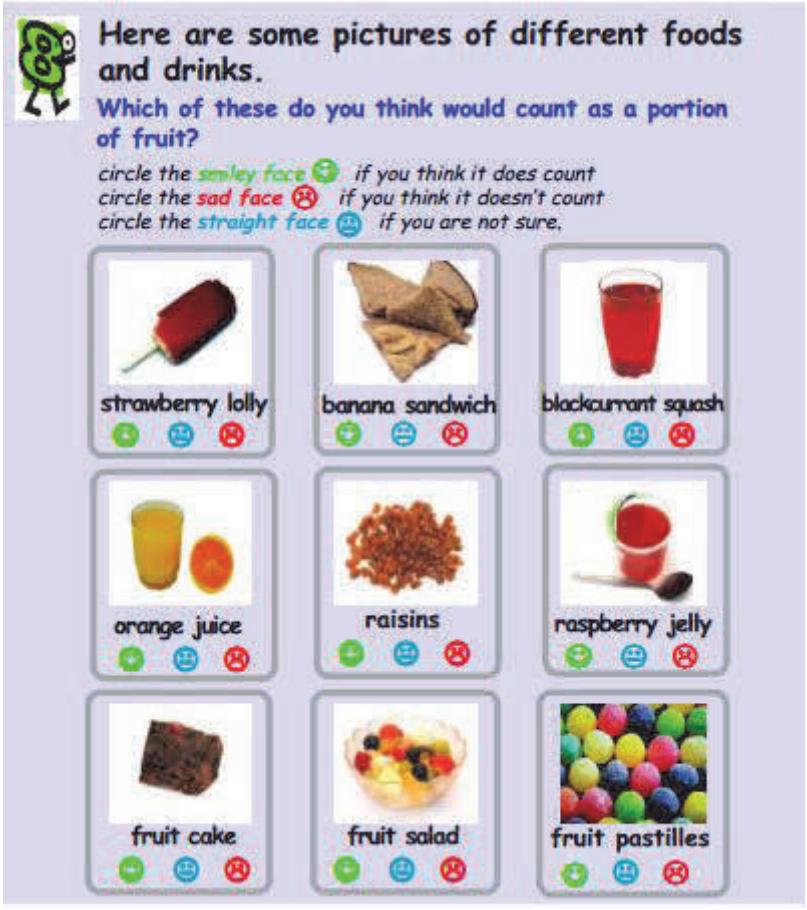
Appendix B

*Knowledge about healthy eating (cont.)*



Appendix B

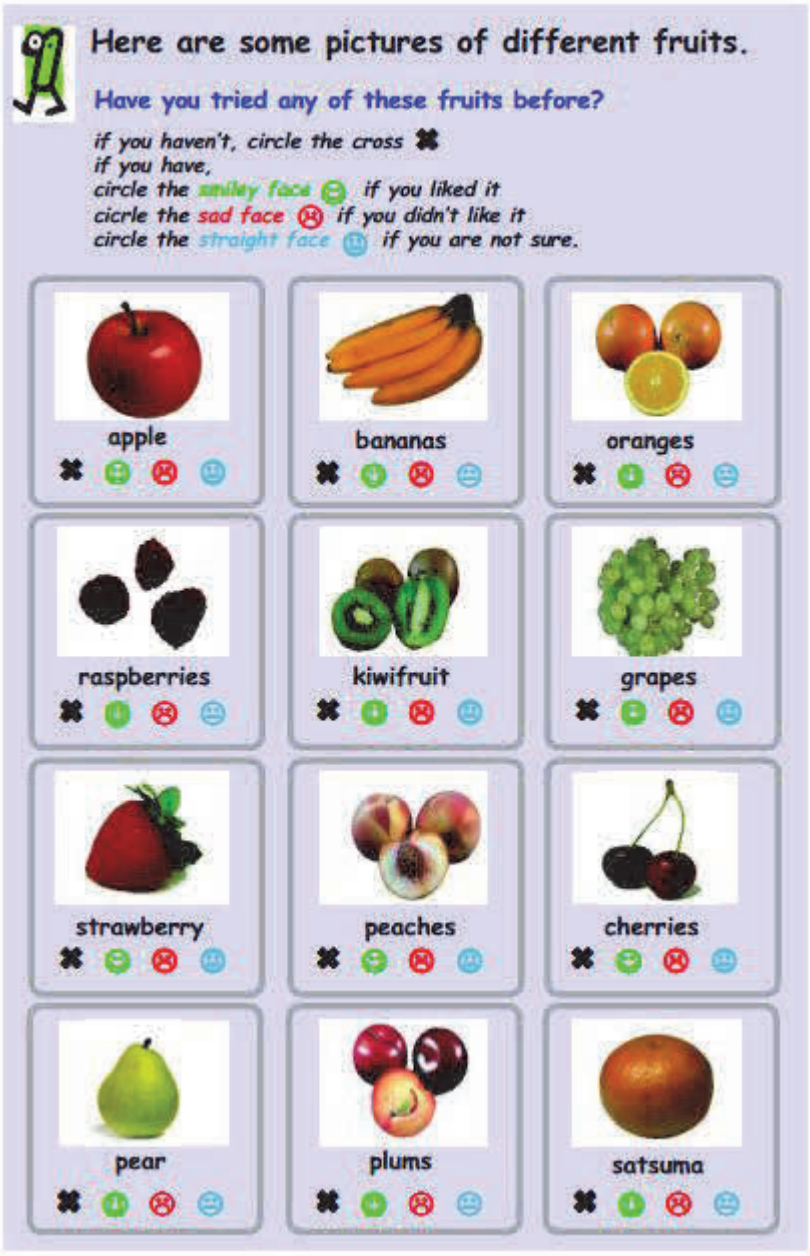
*Knowledge about healthy eating (cont.)*



Appendix B

*Trying and liking fruits*

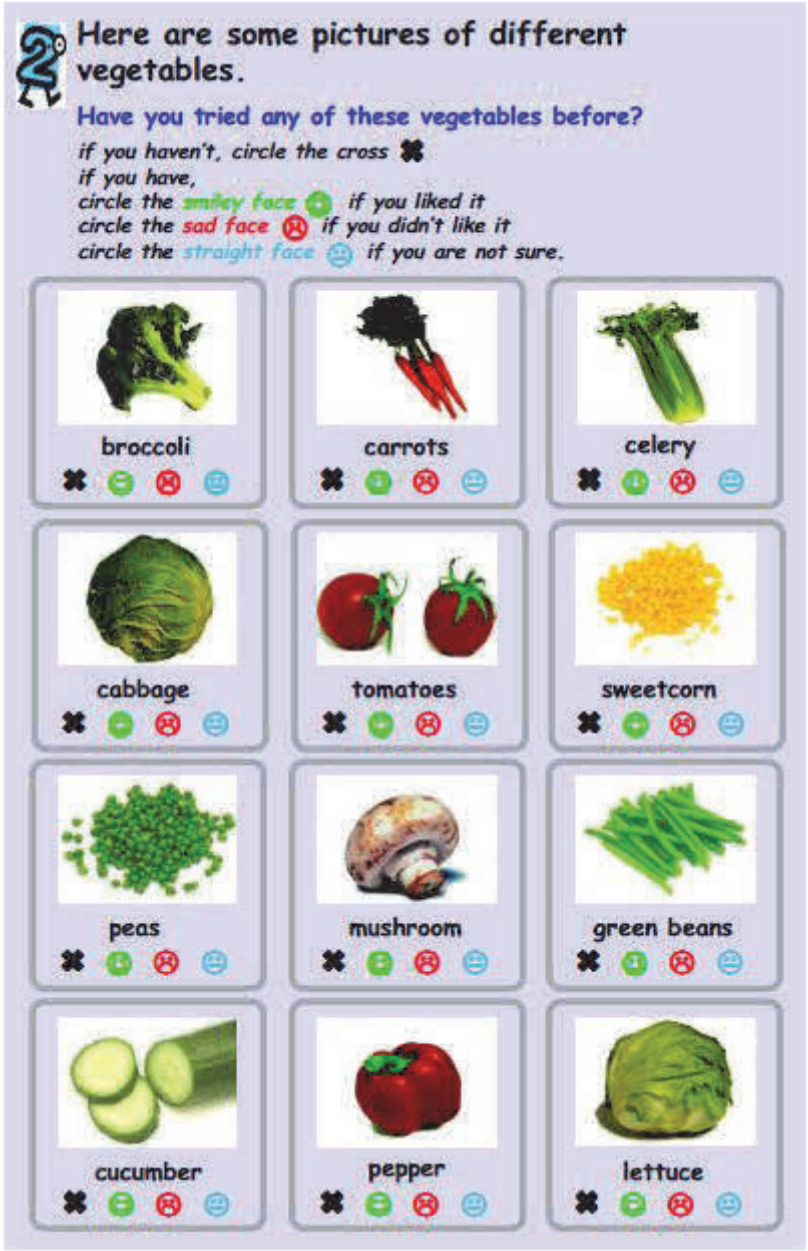
– (Schagen et al., 2005)



Appendix B

*Trying and liking vegetables*

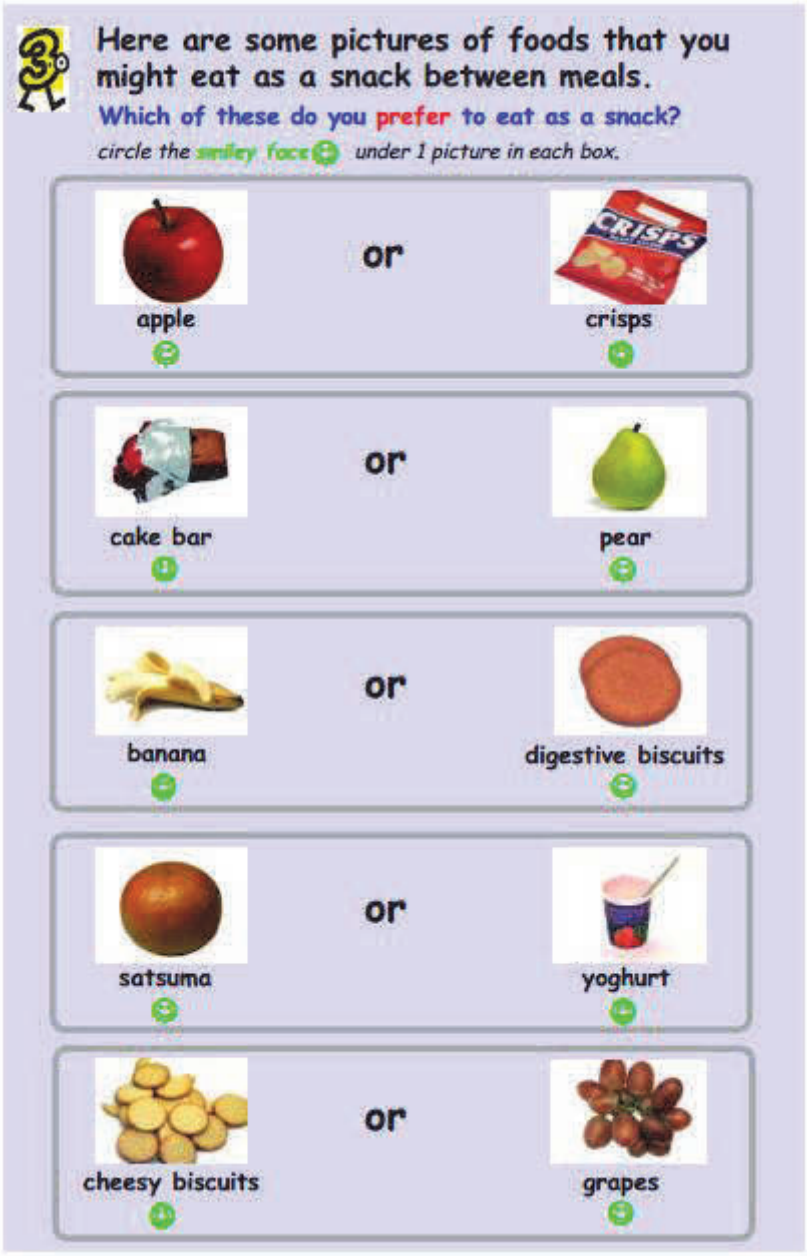
– (Schagen et al., 2005)



Appendix B

*Food preferences*

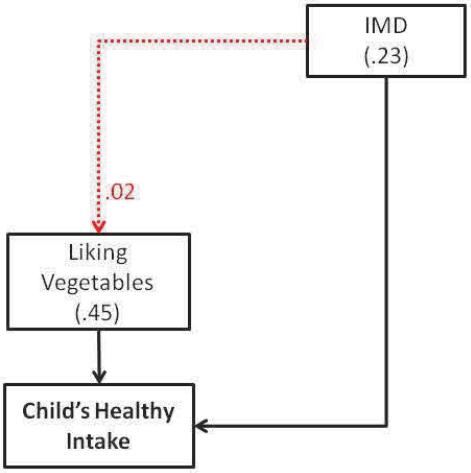
– (Schagen et al., 2005)



## Appendix C

- Path diagrams showing direct and indirect predictors of child healthy intake. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients (β) are presented above each arrow.
- The black dashed arrows represent the indirect effects, i.e. the pathways mediated through at least one intermediate correlate (e.g. Availability -> temptation).
- The grey dashed arrows represent the interaction effects (e.g. Intention x Inhibitory control > food choice).
- The solid arrows show the direct effects which are going straight from the independent variable to the child's healthy intake.
- The red arrows in each modules represent a non-significant path, this information helped on the decision to construct the next model.
- The standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name.
- The final model only presented significant effects ($p$<.05) which are represented by arrows.

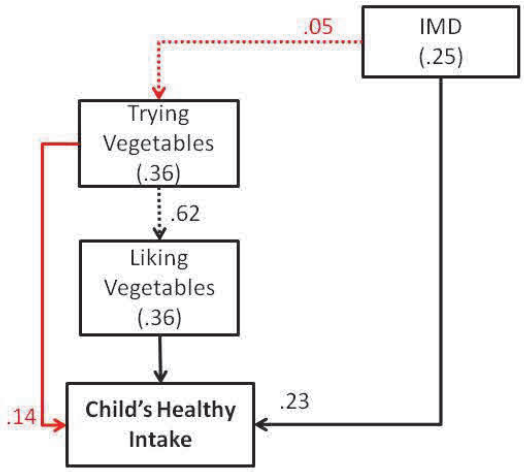
Model 1




Model fit: $\chi^2(0) = .00$, RMSEA = .309 [90%CI = .25, .38], GFI = 1.00, CFI = 1.00

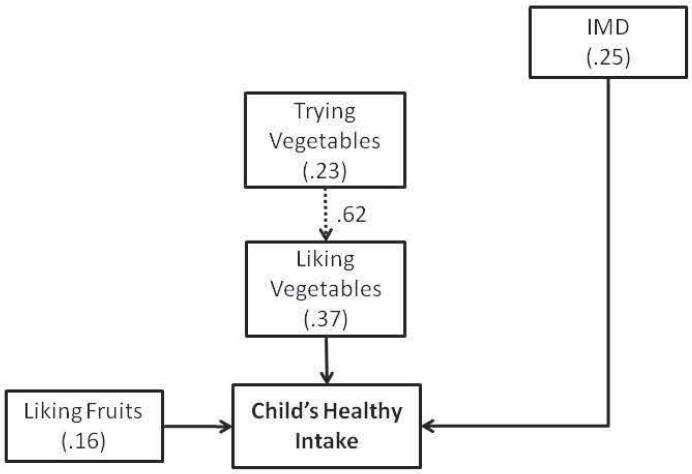
## Appendix C

Model 2




Model fit: $\chi^2(1) = .02$, p=.88, RMSEA = .00 [90%CI = .00, .09], GFI = 1.00, CFI = 1.00

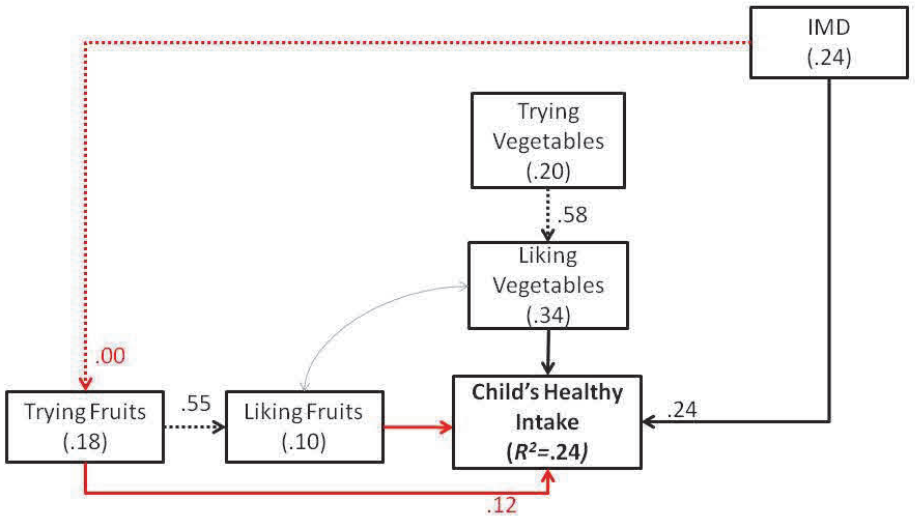
Model 3




Model fit: $\chi^2(6) = 100.74$, p<.001, RMSEA = .27 [90%CI = .23, .32], GFI = .87, CFI = .64

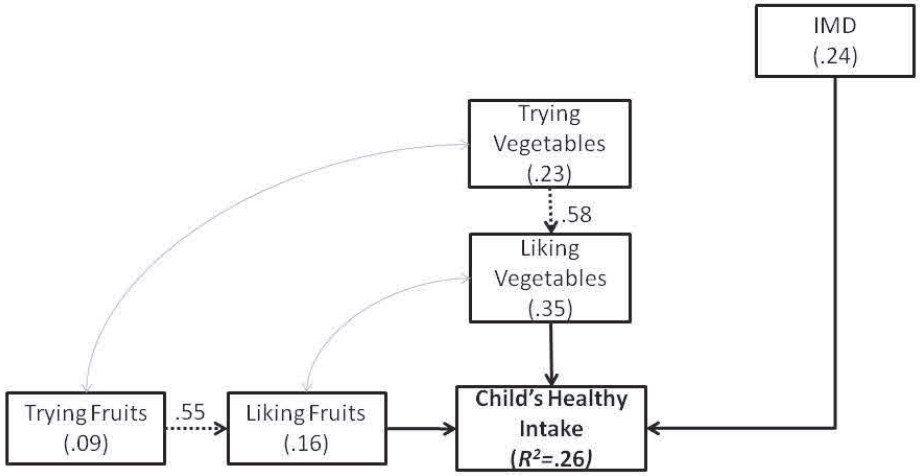
## Appendix C

Model 4



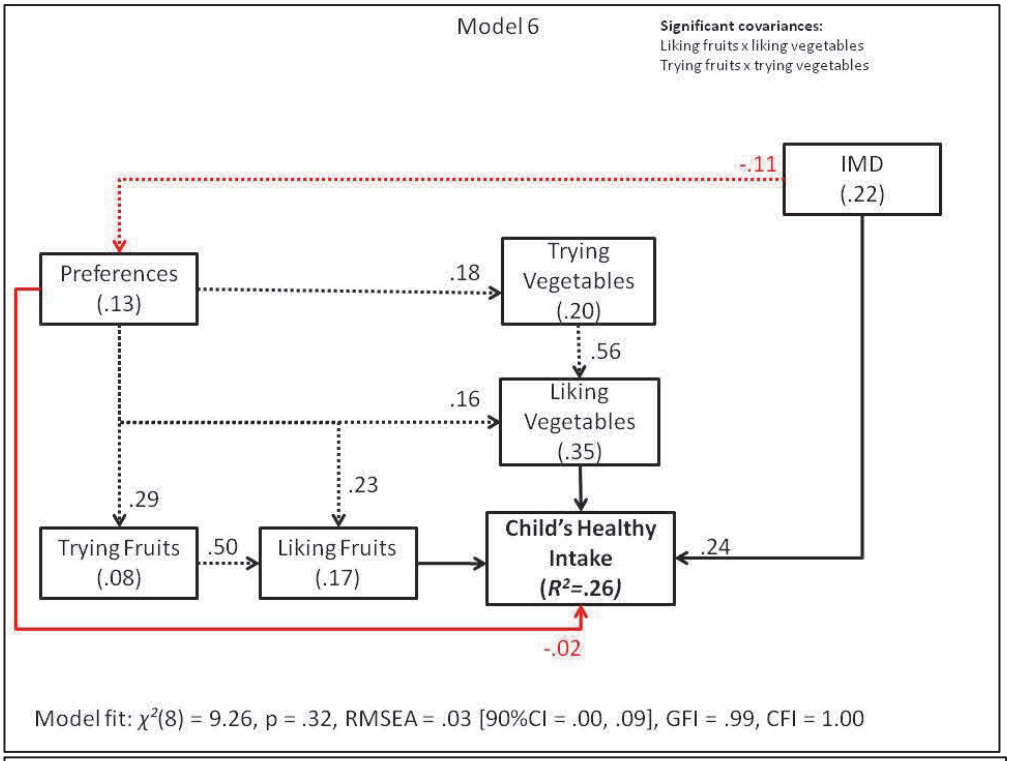

Model fit: $\chi^2(7) = 115.03$, p<.001, RMSEA = .27 [90%CI = .23, .31], GFI = .88, CFI = .74

Model 5

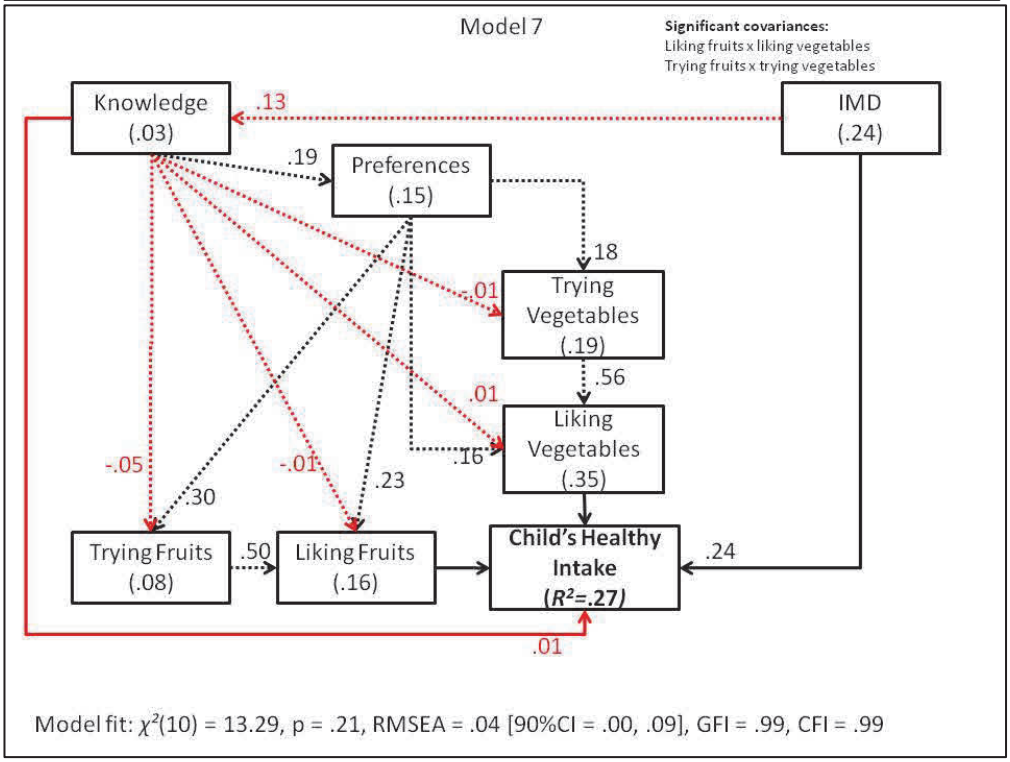



Model fit: $\chi^2(8) = 9.63$, p =.29, RMSEA = .03 [90%CI = .00, .09], GFI = .99, CFI = 1.00

## Appendix C

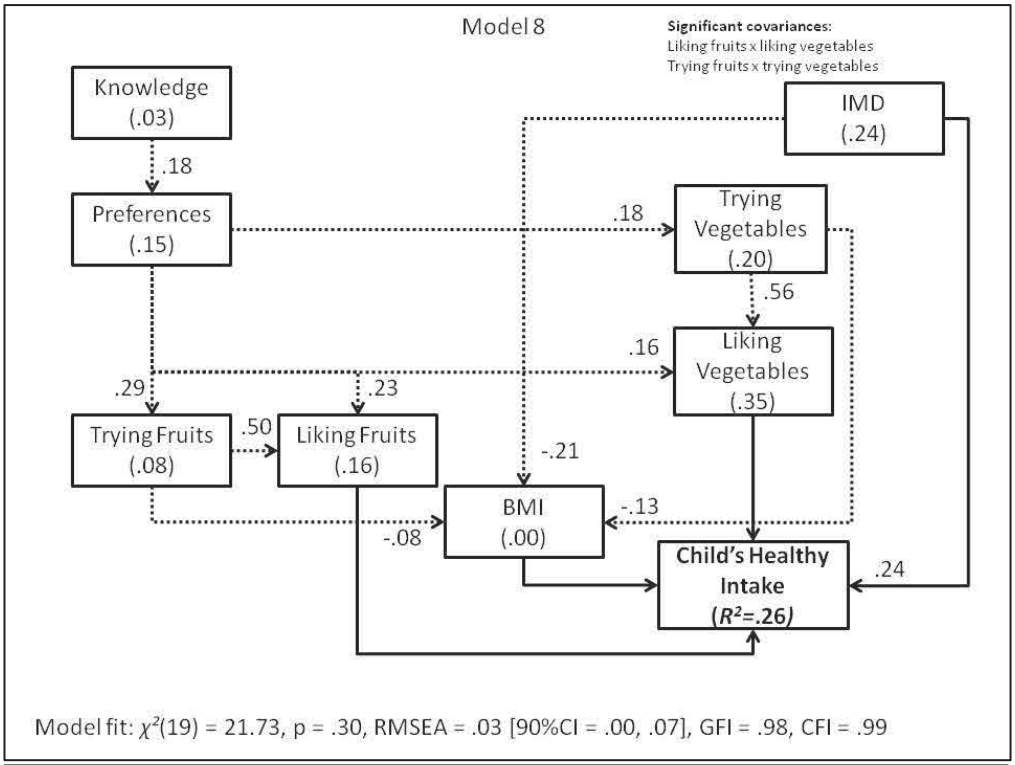



Model fit: $\chi^2(8) = 9.26$, p = .32, RMSEA = .03 [90%CI = .00, .09], GFI = .99, CFI = 1.00

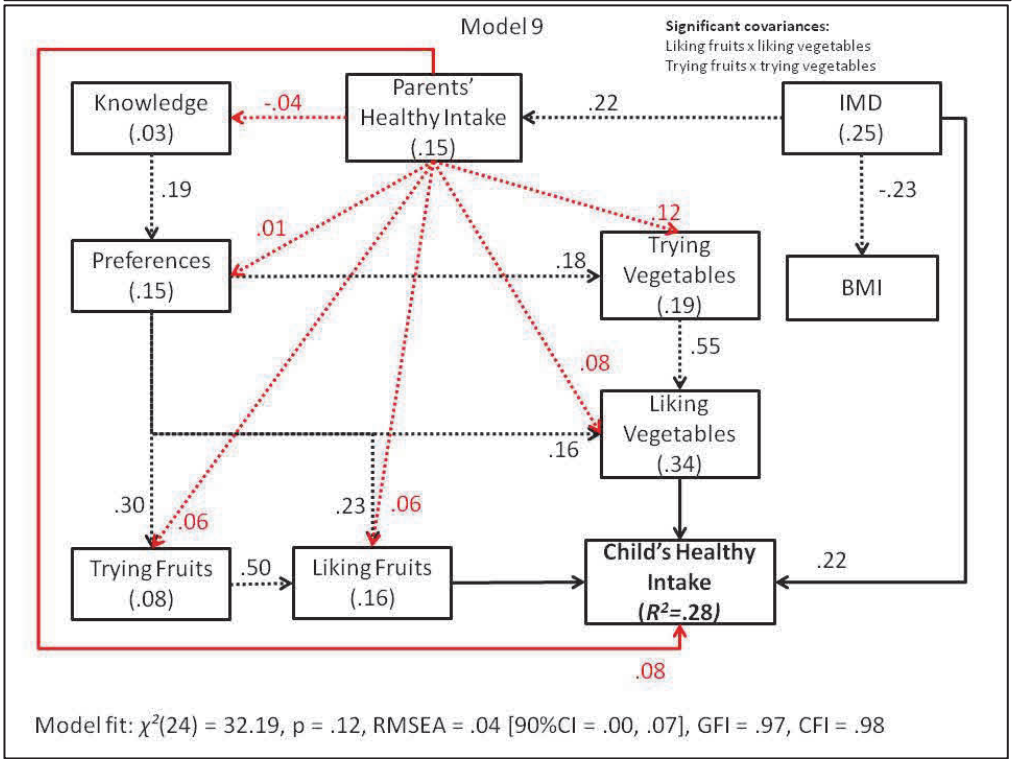



Model fit: $\chi^2(10) = 13.29$, p = .21, RMSEA = .04 [90%CI = .00, .09], GFI = .99, CFI = .99

## Appendix C

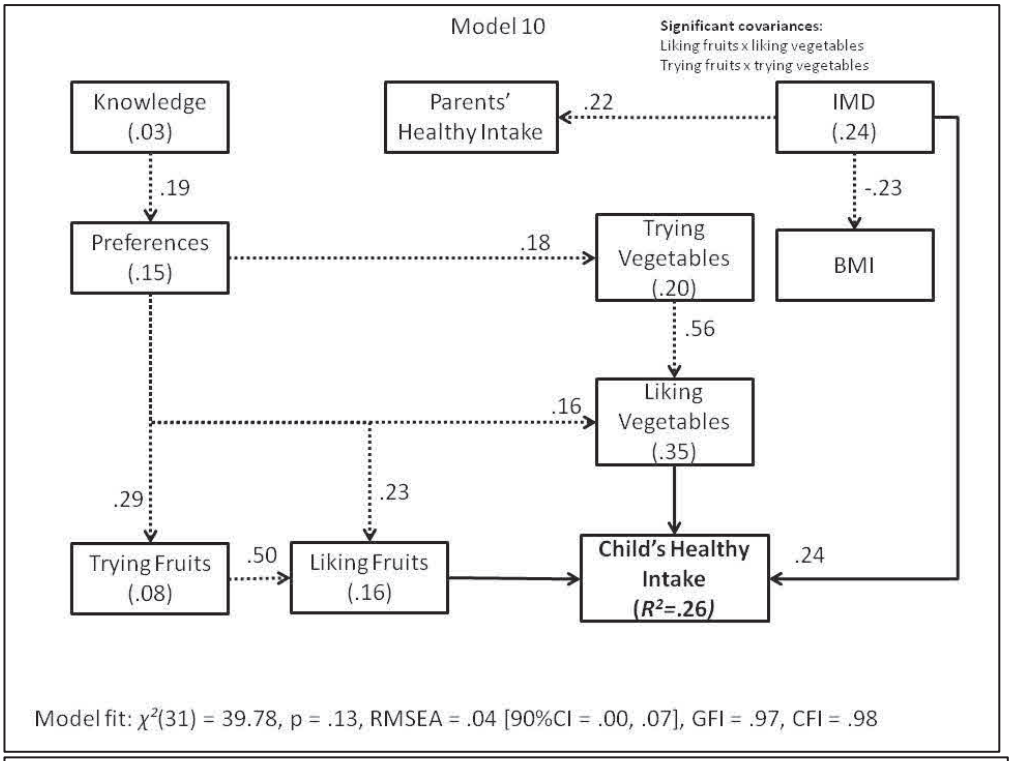


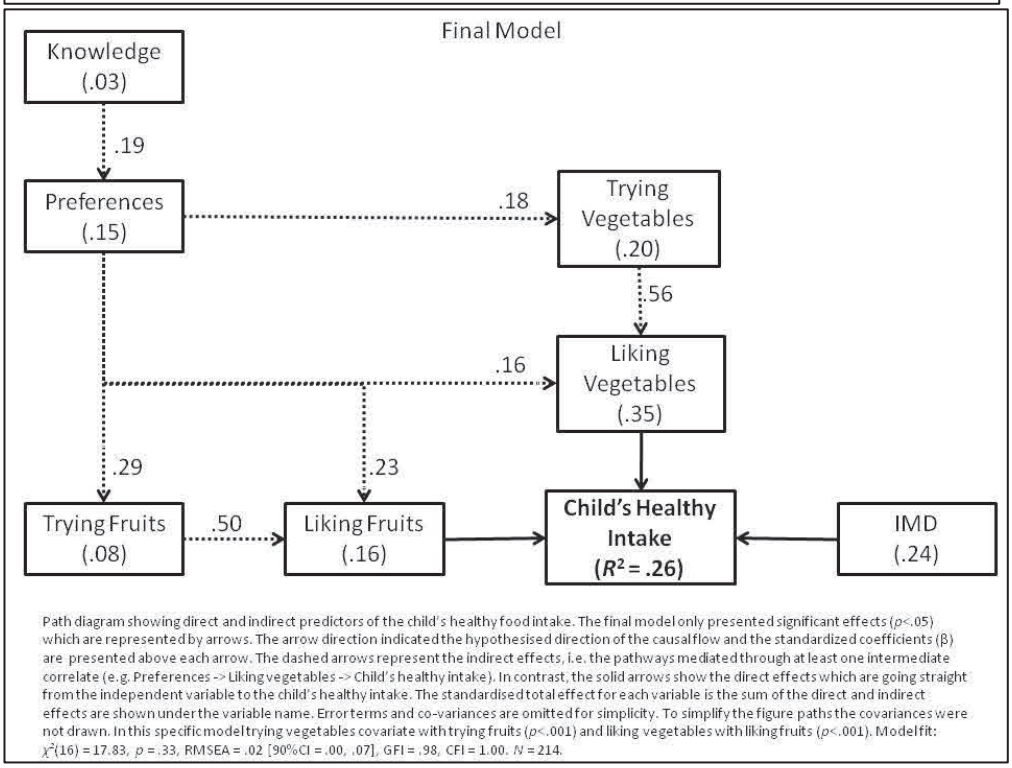

Model fit: $\chi^2(19) = 21.73$, p = .30, RMSEA = .03 [90%CI = .00, .07], GFI = .98, CFI = .99




Model fit: $\chi^2(24) = 32.19$, p = .12, RMSEA = .04 [90%CI = .00, .07], GFI = .97, CFI = .98

## Appendix C



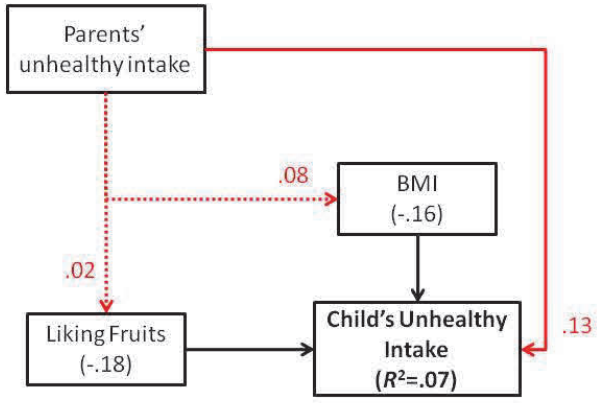




Path diagram showing direct and indirect predictors of the child's healthy food intake. The final model only presented significant effects ($p$<.05) which are represented by arrows. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients (β) are presented above each arrow. The dashed arrows represent the indirect effects, i.e. the pathways mediated through at least one intermediate correlate (e.g. Preferences -> Liking vegetables -> Child's healthy intake). In contrast, the solid arrows show the direct effects which are going straight from the independent variable to the child's healthy intake. The standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name. Error terms and co-variances are omitted for simplicity. To simplify the figure paths the covariances were not drawn. In this specific model trying vegetables covariate with trying fruits ($p$<.001) and liking vegetables with liking fruits ($p$<.001). Model fit: $\chi^2(16)$ = 17.83, $p$ = .33, RMSEA = .02 [90%CI = .00, .07], GFI = .98, CFI = 1.00. $N$ = 214.

Appendix D

- Path diagrams showing direct and indirect predictors of child healthy intake. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients (β) are presented above each arrow.
- The black dashed arrows represent the indirect effects, i.e. the pathways mediated through at least one intermediate correlate (e.g. Availability -> temptation).
- The grey dashed arrows represent the interaction effects (e.g. Intention x Inhibitory control > food choice).
- The solid arrows show the direct effects which are going straight from the independent variable to the child's healthy intake.
- The red arrows in each modules represent a non-significant path, this information helped on the decision to construct the next model.
- The standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name.
- The final model only presented significant effects ($p$<.05) which are represented by arrows.

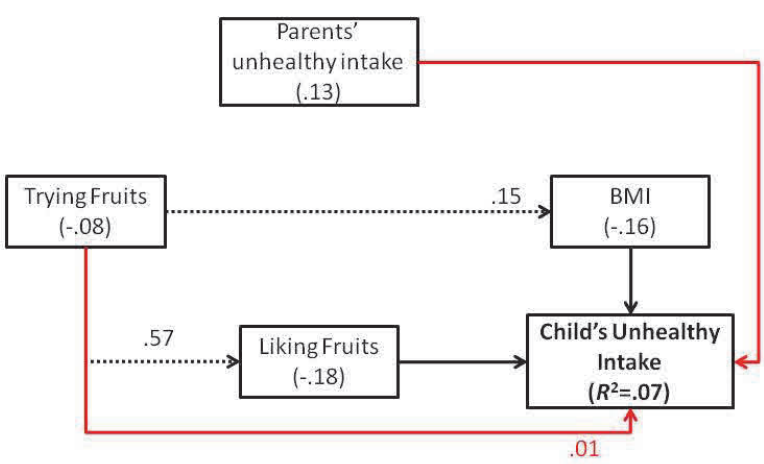
Model 1




Model fit: $\chi^2(1) = .44$, p = .51; RMSEA = .00 [90%CI = .00, .16], GFI = 1.00, CFI = 1.00

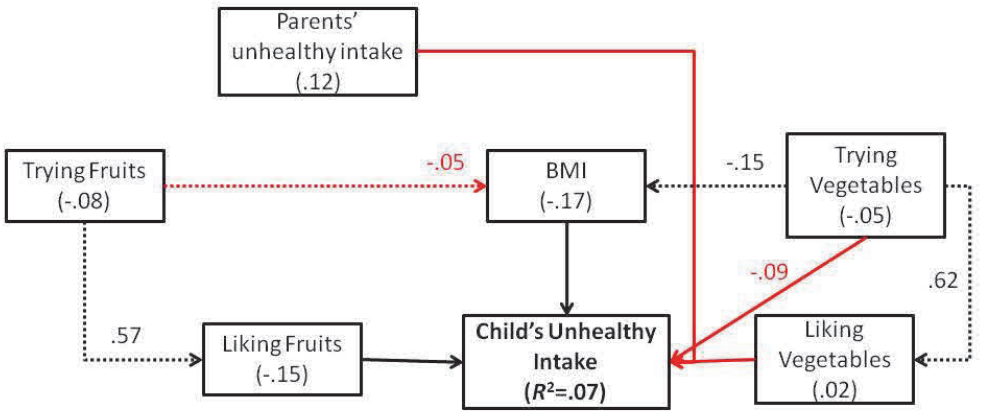
## Appendix D

Model 2




Model fit: $\chi^2(4) = 2.33$, p = .68; RMSEA = .00 [90%CI = .00, .08], GFI = 1.00, CFI = 1.00

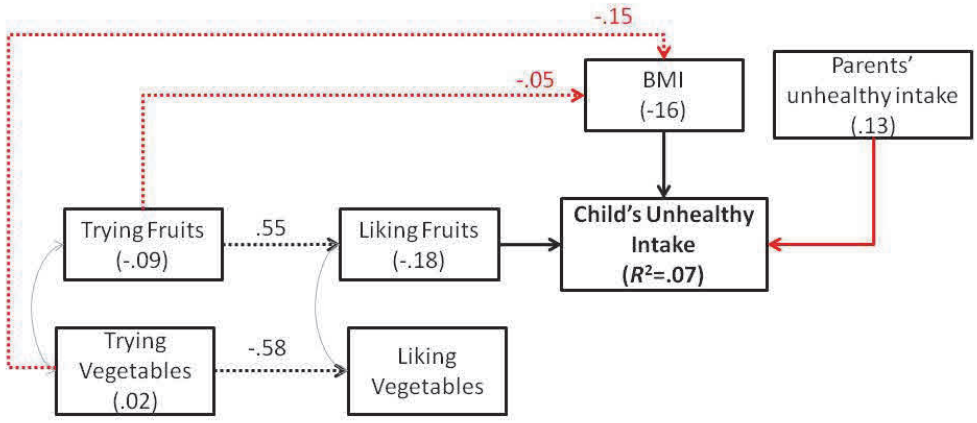
Model 3




Model fit: $\chi^2(12) = 174.53$, p < .001; RMSEA = .25 [90%CI = .22, .29], GFI = .84, CFI = .55

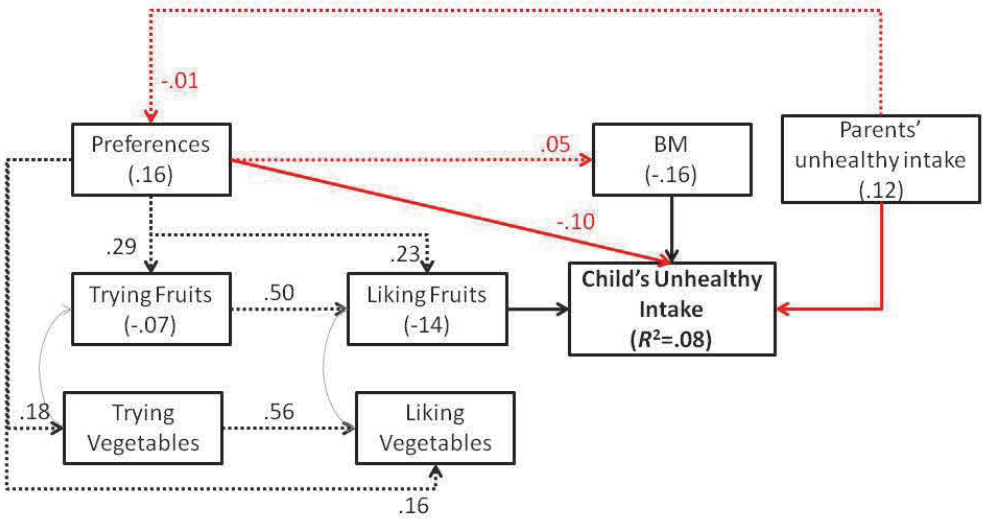
## Appendix D

Model 4



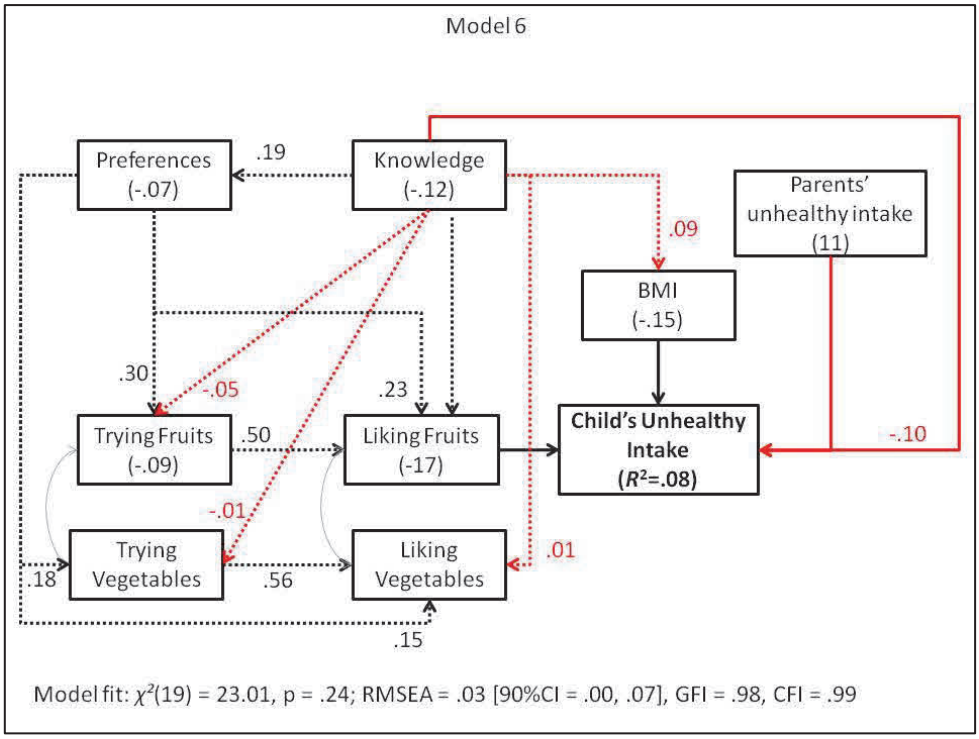

Model fit: $\chi^2(12) = 10.251$, p = .59; RMSEA = .00 [90%CI = .00, .06], GFI = .99, CFI = 1.00

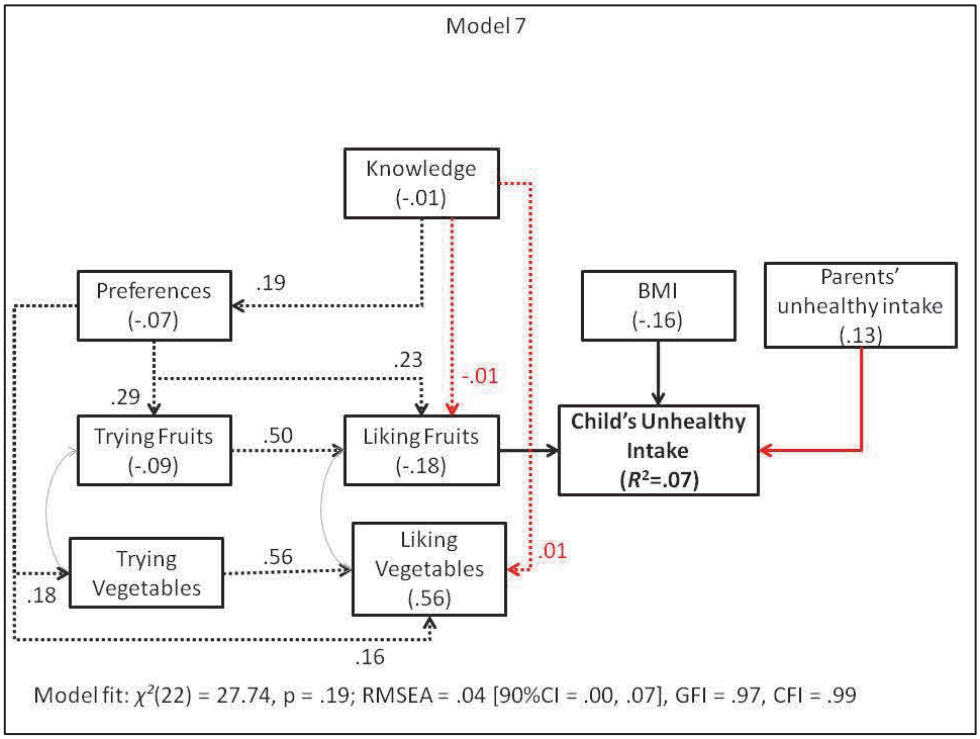
Model 5



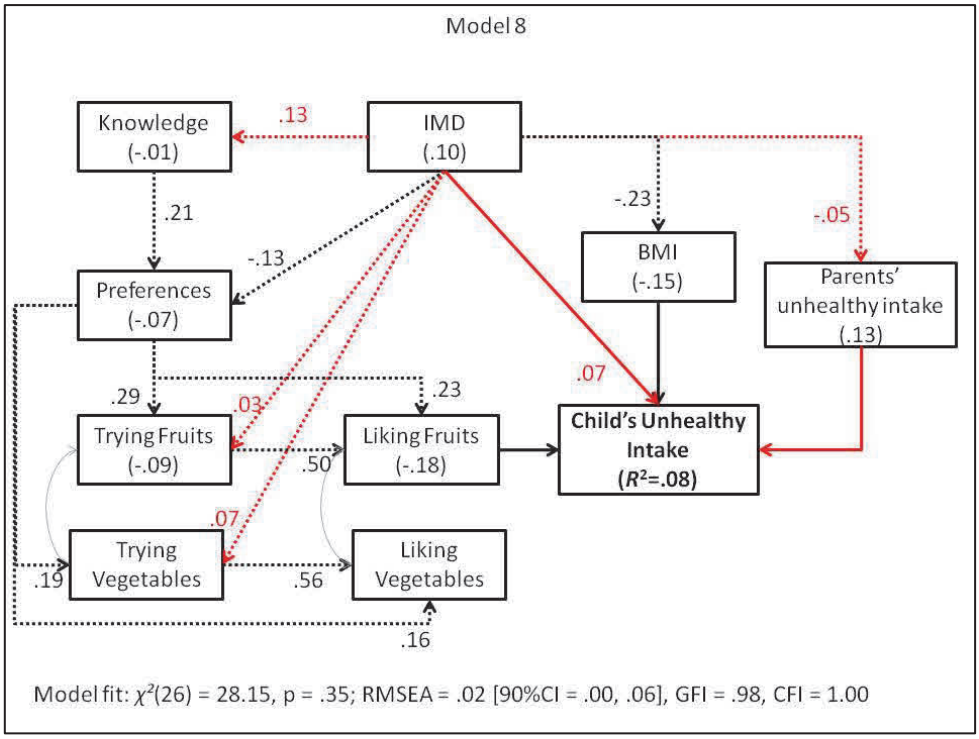

Model fit: $\chi^2(14) = 18.17$, p = .20; RMSEA = .04 [90%CI = .00, .08], GFI = .99, CFI = .99

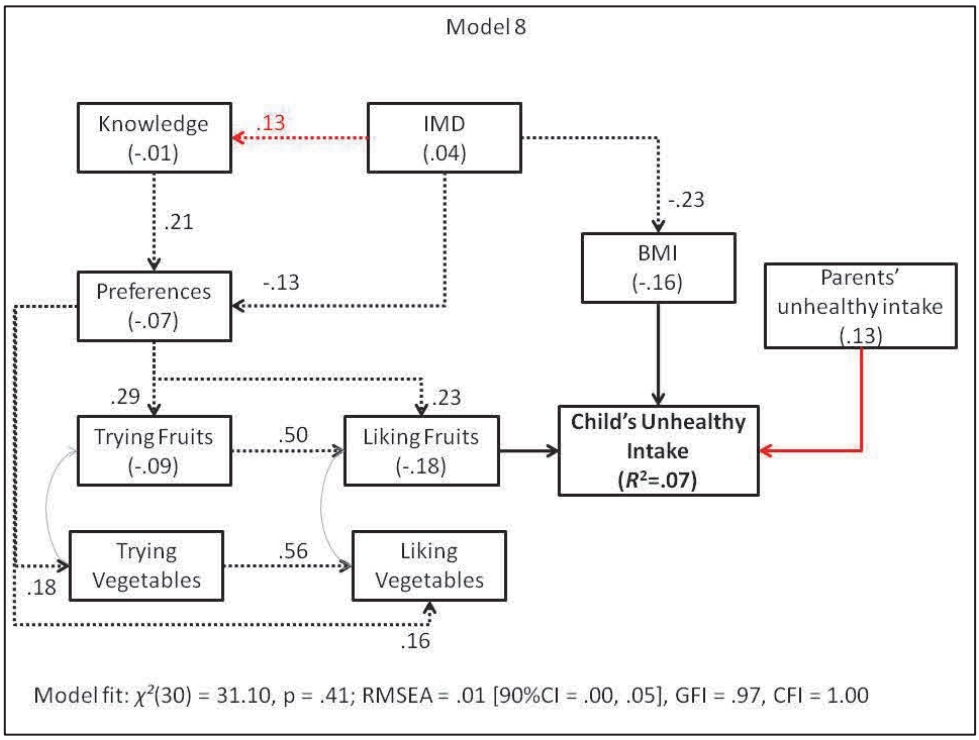
## Appendix D


Model 6
Preferences (-.07)
.19
Knowledge (-.12)
Parents' unhealthy intake (11)
.09
BMI (-.15)
.30
-.05
.23
Trying Fruits (-.09)
.50
Liking Fruits (-17)
Child's Unhealthy Intake ($R^2$=.08)
-.10
-.01
.01
.18
Trying Vegetables
.56
Liking Vegetables
.15
Model fit: $\chi^2$(19) = 23.01, p = .24; RMSEA = .03 [90%CI = .00, .07], GFI = .98, CFI = .99

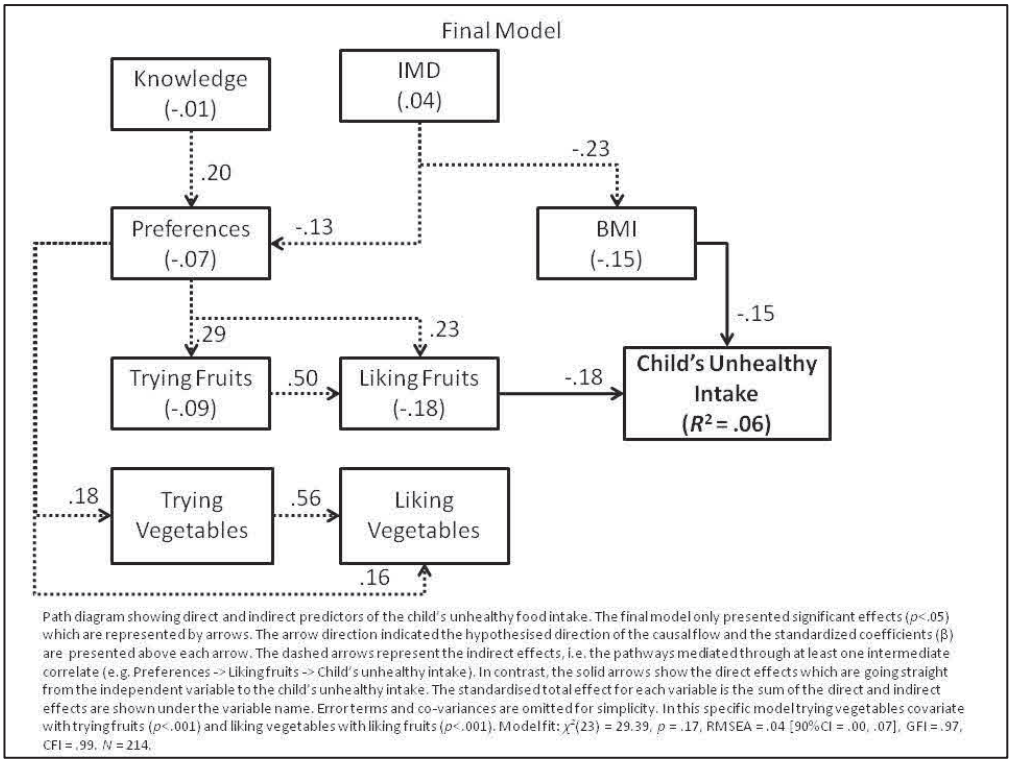

Model 7
Knowledge (-.01)
Preferences (-.07)
.19
BMI (-.16)
Parents' unhealthy intake (.13)
.23
-.01
.29
Trying Fruits (-.09)
.50
Liking Fruits (-.18)
Child's Unhealthy Intake ($R^2$=.07)
Trying Vegetables
.56
Liking Vegetables (.56)
.01
.18
.16
Model fit: $\chi^2$(22) = 27.74, p = .19; RMSEA = .04 [90%CI = .00, .07], GFI = .97, CFI = .99

## Appendix D


Model 8
Knowledge (-.01)
IMD (.10)
.13
.21
-.23
-.05
-.13
BMI (-.15)
Parents' unhealthy intake (.13)
Preferences (-.07)
.07
.29
.23
.03
Trying Fruits (-.09)
Liking Fruits (-.18)
Child's Unhealthy Intake ($R^2$=.08)
.50
.07
Trying Vegetables
Liking Vegetables
.19
.56
.16
Model fit: $\chi^2(26) = 28.15$, p = .35; RMSEA = .02 [90%CI = .00, .06], GFI = .98, CFI = 1.00


Model 8
Knowledge (-.01)
IMD (.04)
.13
.21
-.23
BMI (-.16)
Parents' unhealthy intake (.13)
Preferences (-.07)
-.13
.29
.23
Trying Fruits (-.09)
.50
Liking Fruits (-.18)
Child's Unhealthy Intake ($R^2$=.07)
Trying Vegetables
Liking Vegetables
.18
.56
.16
Model fit: $\chi^2(30) = 31.10$, p = .41; RMSEA = .01 [90%CI = .00, .05], GFI = .97, CFI = 1.00

## Appendix D




Path diagram showing direct and indirect predictors of the child's unhealthy food intake. The final model only presented significant effects ($p$<.05) which are represented by arrows. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients (β) are presented above each arrow. The dashed arrows represent the indirect effects, i.e. the pathways mediated through at least one intermediate correlate (e.g. Preferences -> Liking fruits -> Child's unhealthy intake). In contrast, the solid arrows show the direct effects which are going straight from the independent variable to the child's unhealthy intake. The standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name. Error terms and co-variances are omitted for simplicity. In this specific model trying vegetables covariate with trying fruits ($p$<.001) and liking vegetables with liking fruits ($p$<.001). Model fit: $\chi^2(23) = 29.39$, $p = .17$, RMSEA = .04 [90%CI = .00, .07], GFI = .97, CFI = .99. $N$ = 214.

Appendix E

| Variable | | Items |
|---|---|---|
| **Hunger** | | At this moment, how hungry are you?<br>*Not hungry at all (5) Extremely hungry* |
| **Temptation** | | To me, [name of the food picture[9] on the screen] is a temptation, difficult to resist eating it.<br>*strongly disagree (5) strongly agree* |
| **Availability** | **Healthy** | How often do you have fruits and/or vegetables as snack at home?<br>*never-rarely-sometimes-often -always* |
| | | How often do your parents give you fruits and/or vegetables to eat as a snack between main meals?<br>*never-rarely-sometimes-often -always* |
| | **Unhealthy** | How often do you have sweet and/or savoury snacks at home?<br>*never-rarely-sometimes-often -always* |
| | | How often do your parents give you sweet and/or savoury to eat as a snack between main meals?<br>*never-rarely-sometimes-often -always* |
| **Intention** | **Healthy** | I intend to eat fruits and/or vegetables as snacks, between main meals: *Likely (5) unlikely* |
| | | I will try to eat fruits and/or vegetables as snacks, between main meals: *definitely true (5) definitely false* |
| | | I plan to eat fruits and/or vegetables as snacks, between main meals. *strongly disagree (5) strongly agree* |
| | **Unhealthy** | I intend to eat sweet and/or savoury snacks, between main meals: *Likely (5) unlikely* |
| | | I will try to eat sweet and/or savoury snacks, between main meals: *definitely true (5) definitely false* |
| | | I plan to eat sweet and/or savoury snacks, between main meals. *strongly disagree (5) strongly agree* |
| **Perceived Behavioural Control (PBC)** | **Healthy** | If I wanted to I could eat fruits and/or vegetables as snacks, between main meals: *definitely true (5) definitely false* |
| | | For me to eat fruits and/or vegetables as snacks, between main meals would be: *Impossible (5) possible* |
| | | How much control do you believe you have over eating fruits and/or vegetables as snacks, between main meals:<br>*no control (5) complete control* |
| | **Unhealthy** | If I wanted to I could eat sweet and/or savoury snacks, between main meals: *definitely true (5) definitely false* |
| | | For me to eat sweet and/or savoury snacks, between main meals would be: *Impossible (5) possible* |

[9] Images can be found in appendix F

Appendix E

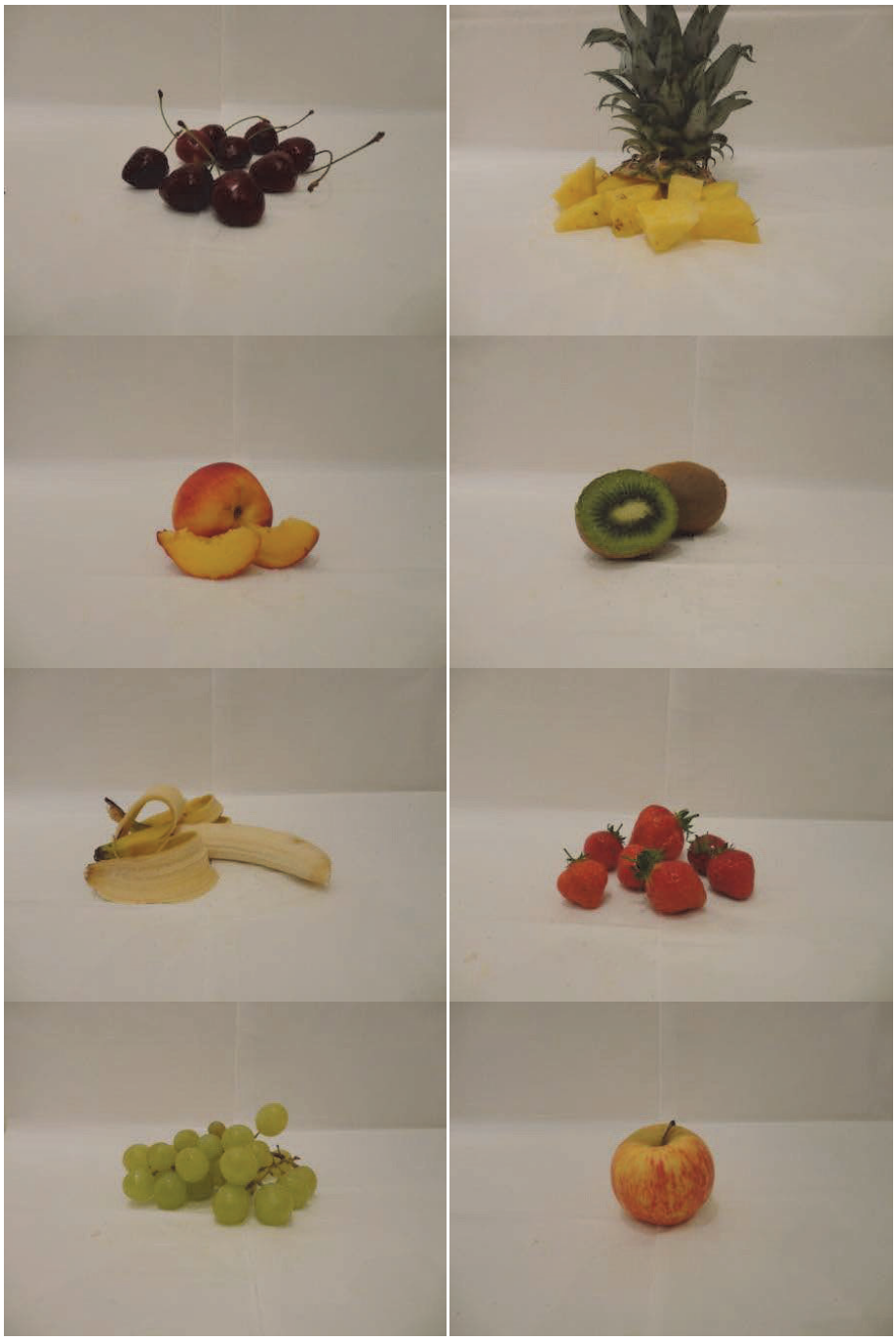
| Variable | Items |
|---|---|
| | How much control do you believe you have over eating sweet and/or savoury snacks, between main meals:<br>*no control (5) complete control* |

(cont.)

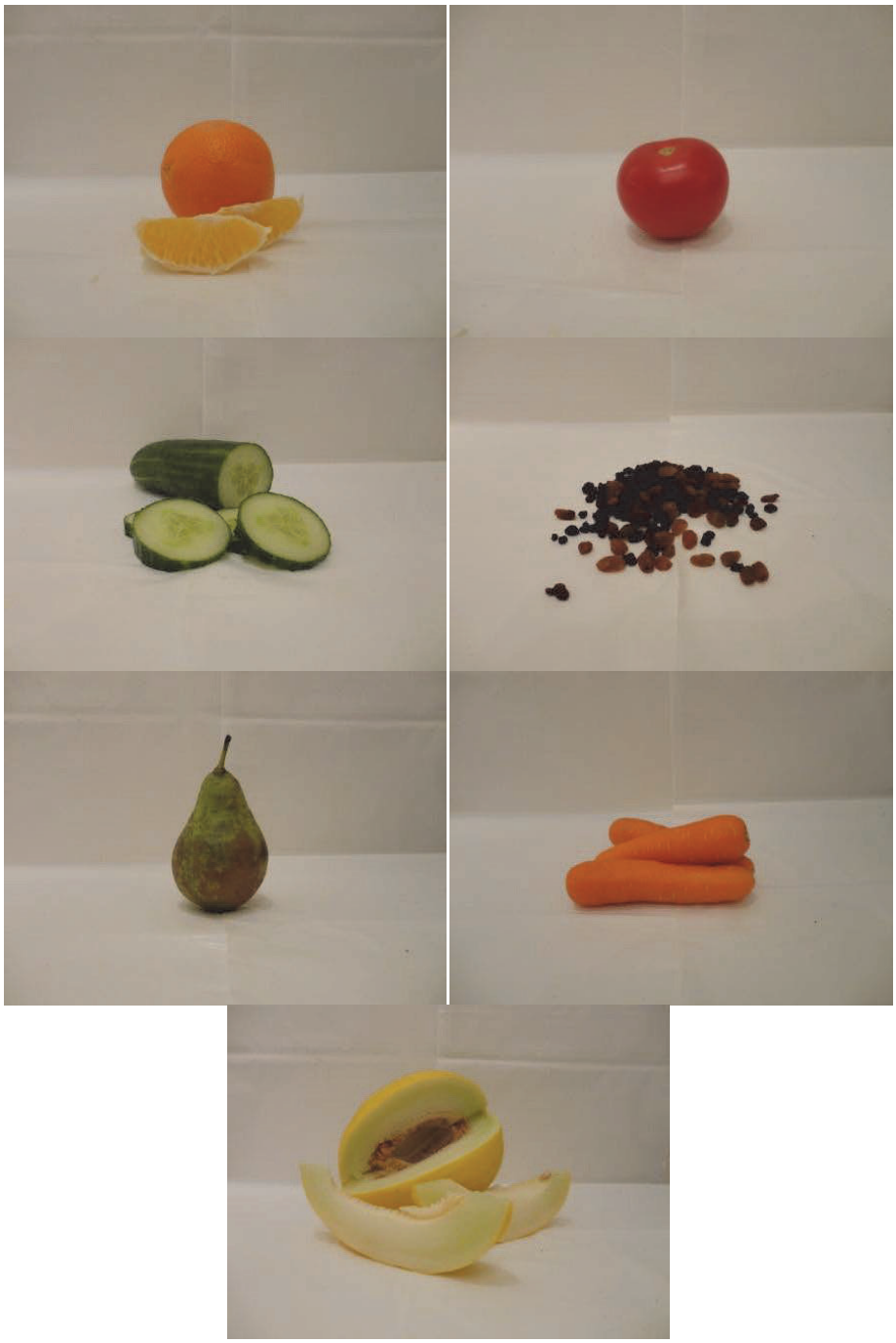
| Variable | | Items |
|---|---|---|
| **Prototypes Evaluation** | **Healthy** | What's your opinion about the type of person, your age who eats fruits and/or vegetables as snacks between main meals?<br>*extremely unfavourable (100) extremely favourable* |
| | **Unhealthy** | What's your opinion about the type of person, your age who eats sweet and/or savoury snacks between main meals?<br>*extremely unfavourable (100) extremely favourable* |
| **Prototypes Similarity** | **Healthy** | In general, how similar are you to the type of person your age who eats fruits and/or vegetables as snacks between main meals? *not at all similar (5) very similar* |
| | **Unhealthy** | In general, how similar are you to the type of person your age who eats sweet and/or savoury snacks between main meals?<br>*not at all similar (5) very similar* |

Appendix F

## Healthy food



Appendix F



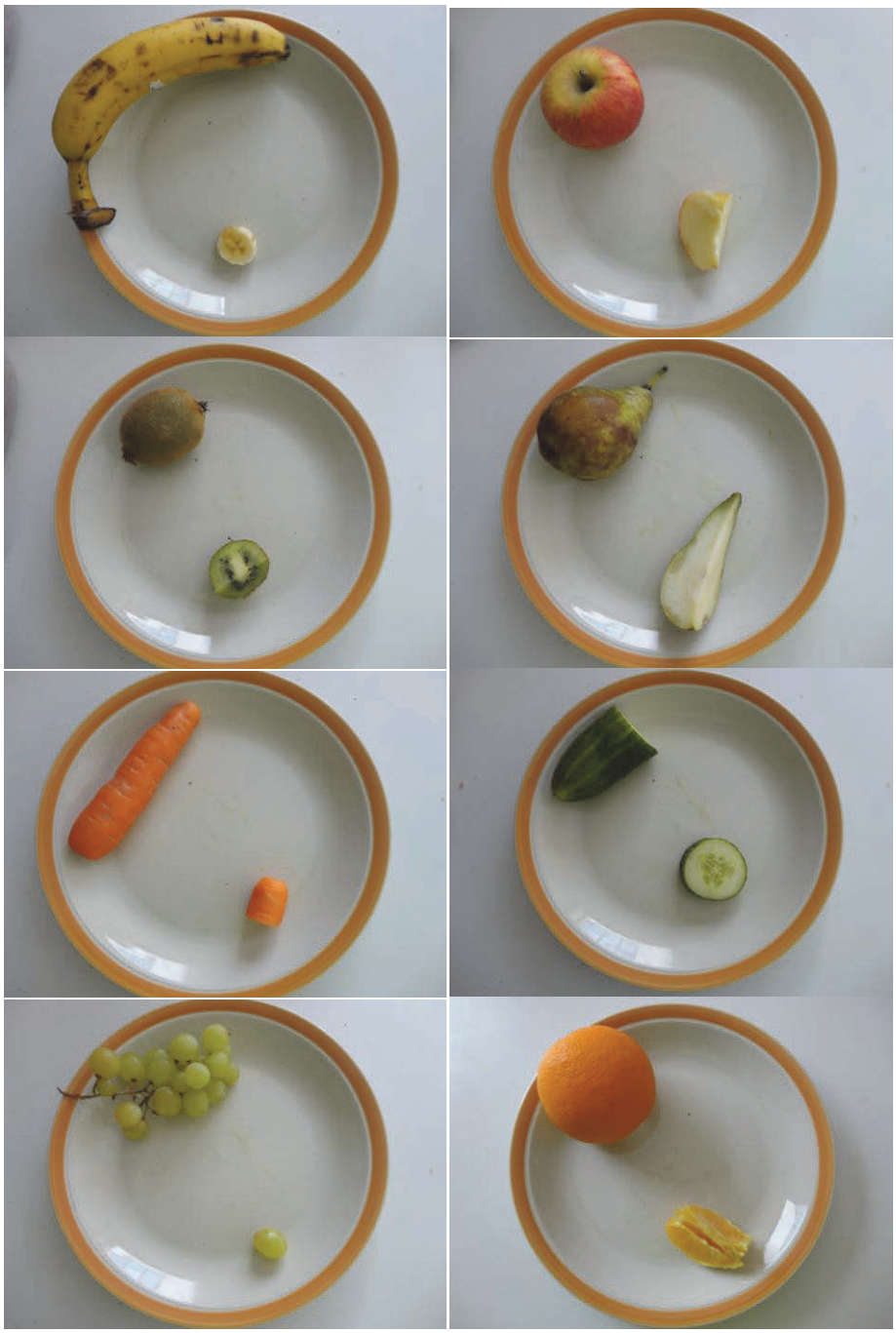
Appendix F

## Unhealthy food

## Appendix F

Appendix G

Healthy food



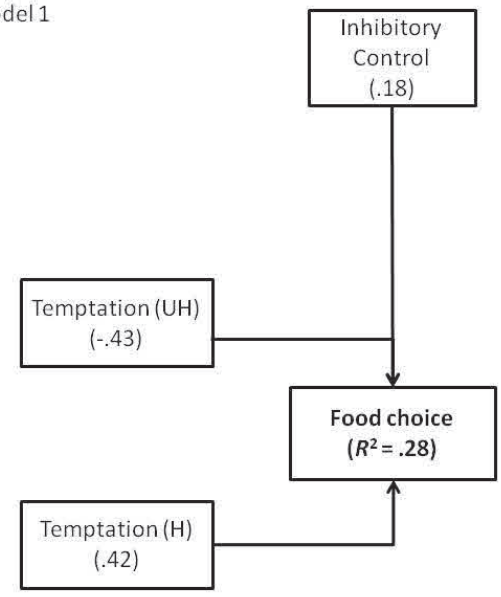
# Appendix G

Unhealthy food

## Appendix H

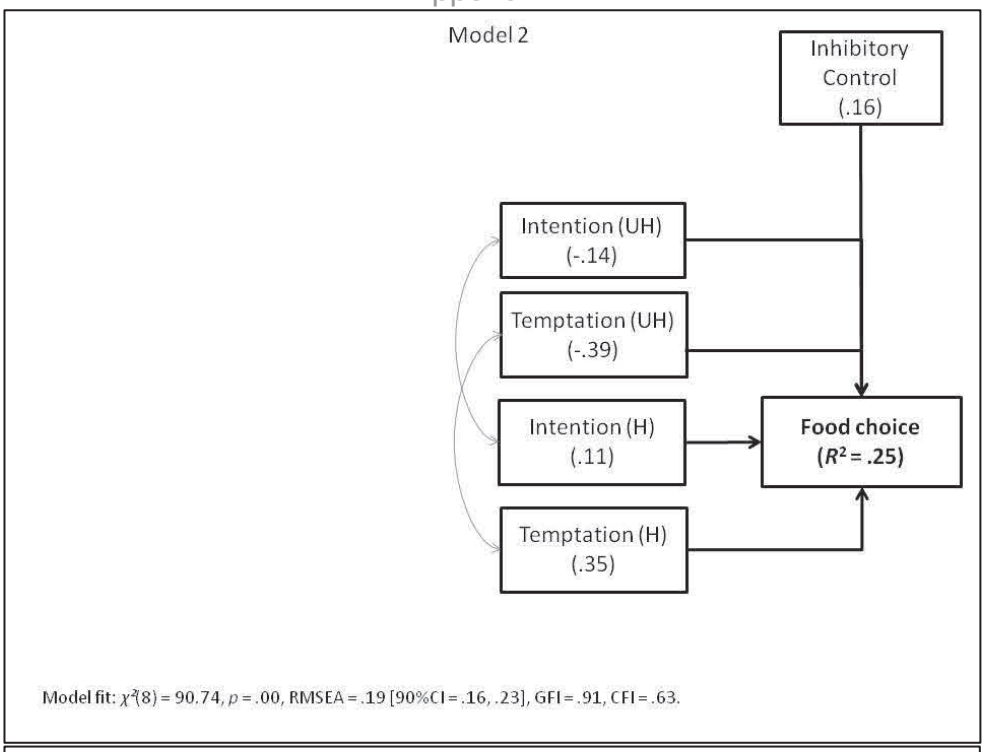
- Path diagrams showing direct and indirect predictors of the adolescents food choice. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients (β) are presented above each arrow.
- The black dashed arrows represent the indirect effects, i.e. the pathways mediated through at least one intermediate correlate (e.g. Availability -> temptation).
- The grey dashed arrows represent the interaction effects (e.g. Intention x Inhibitory control > food choice).
- The solid arrows show the direct effects which are going straight from the independent variable to the child's healthy intake.
- The red arrows in each modules represent a non-significant path, this information helped on the decision to construct the next model.
- The standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name.
- The final model only presented significant effects ($p<.05$) which are represented by arrows.

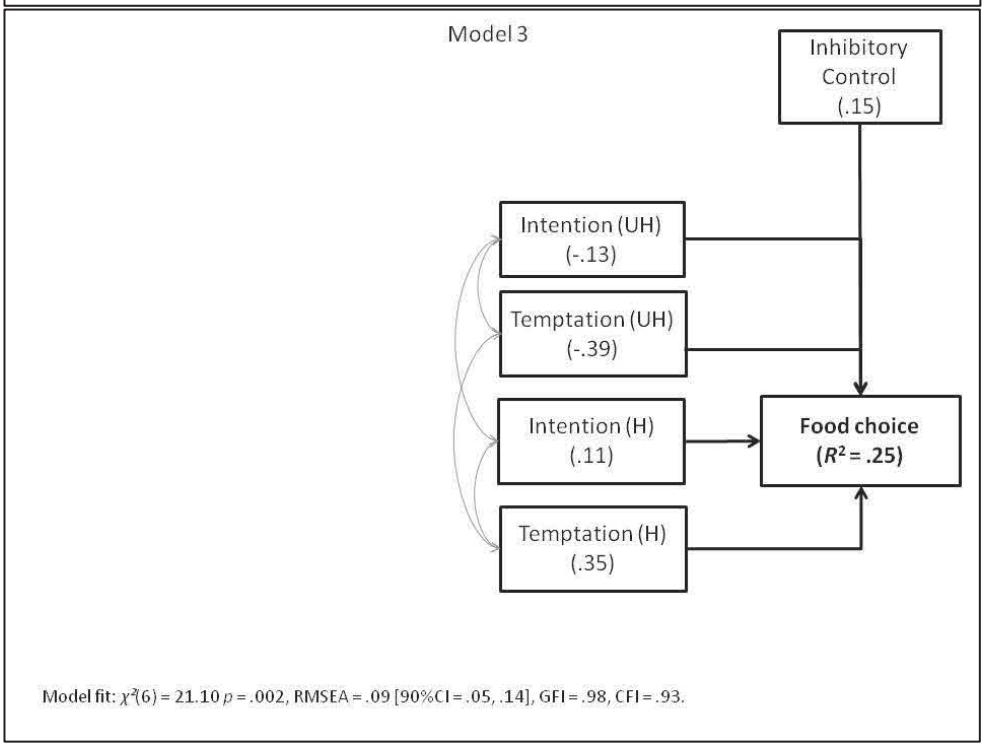
Model 1



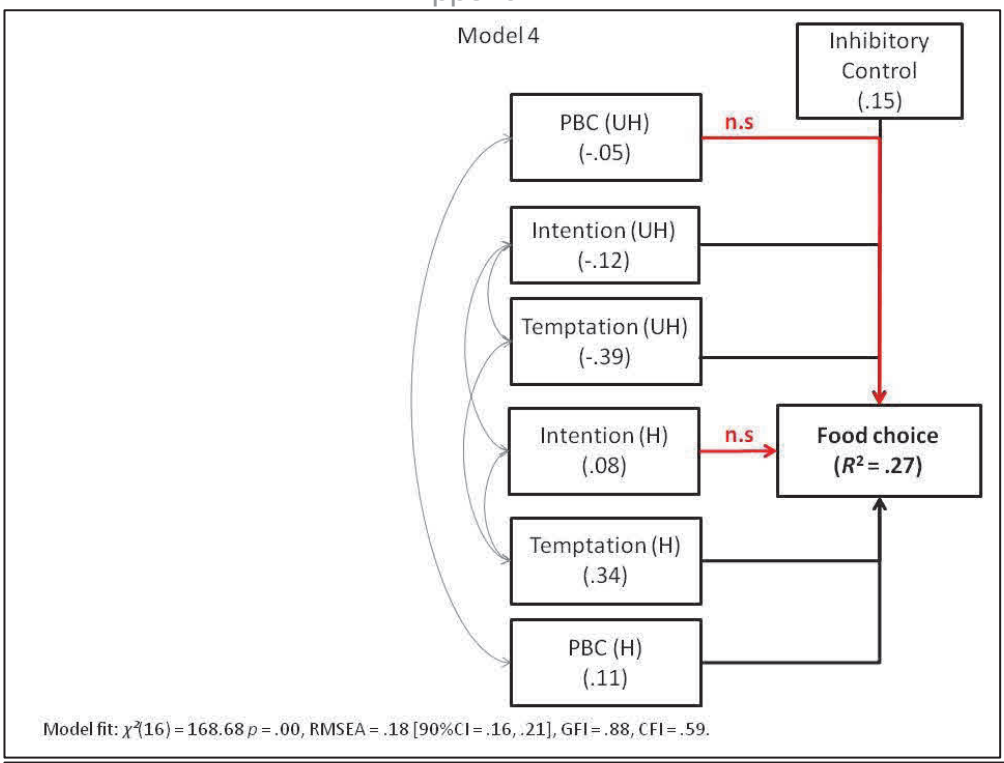

Model fit: $\chi^2(2) = 3.28$, $p = .19$, RMSEA = .048 [90%CI = .00, .14], GFI = .99, CFI = .99.

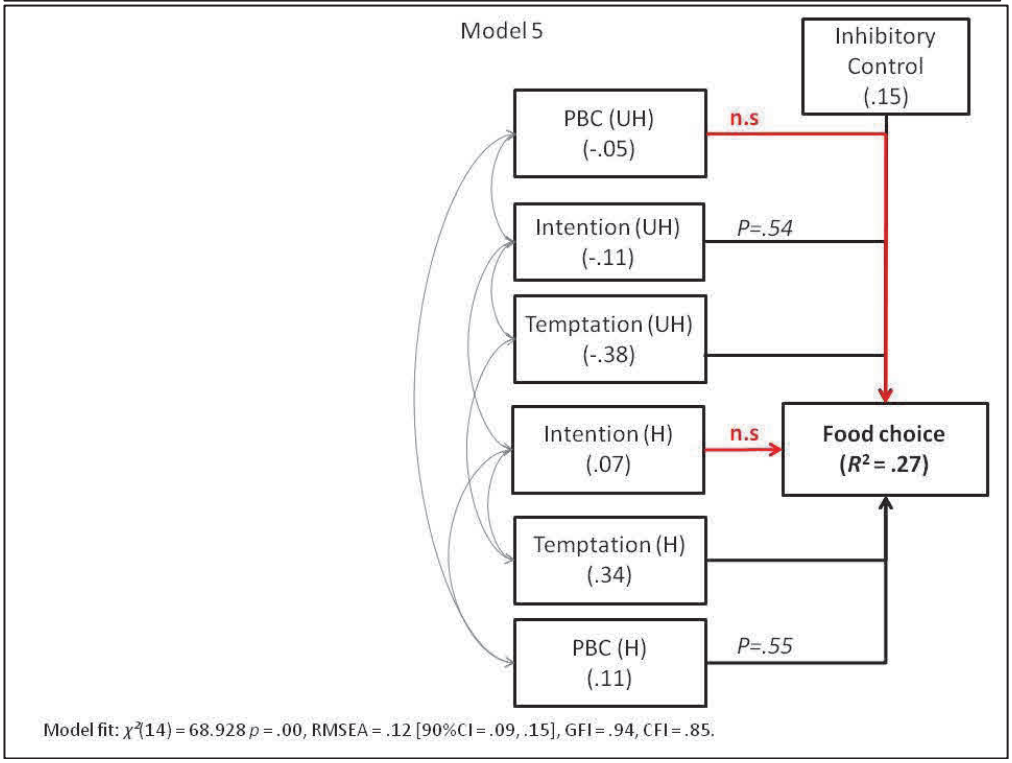
# Appendix H


Model 2
Inhibitory Control (.16)
Intention (UH) (-.14)
Temptation (UH) (-.39)
Intention (H) (.11)
Temptation (H) (.35)
Food choice ($R^2$ = .25)
Model fit: $\chi^2(8) = 90.74$, $p = .00$, RMSEA = .19 [90%CI = .16, .23], GFI = .91, CFI = .63.

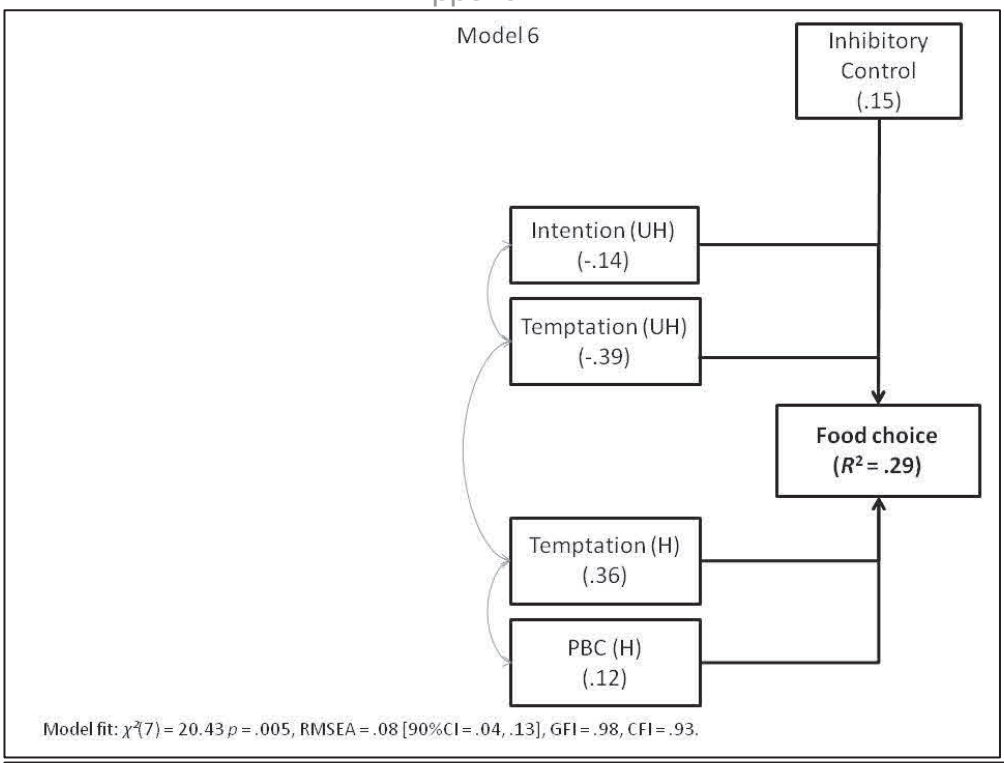

Model 3
Inhibitory Control (.15)
Intention (UH) (-.13)
Temptation (UH) (-.39)
Intention (H) (.11)
Temptation (H) (.35)
Food choice ($R^2$ = .25)
Model fit: $\chi^2(6) = 21.10$ $p = .002$, RMSEA = .09 [90%CI = .05, .14], GFI = .98, CFI = .93.

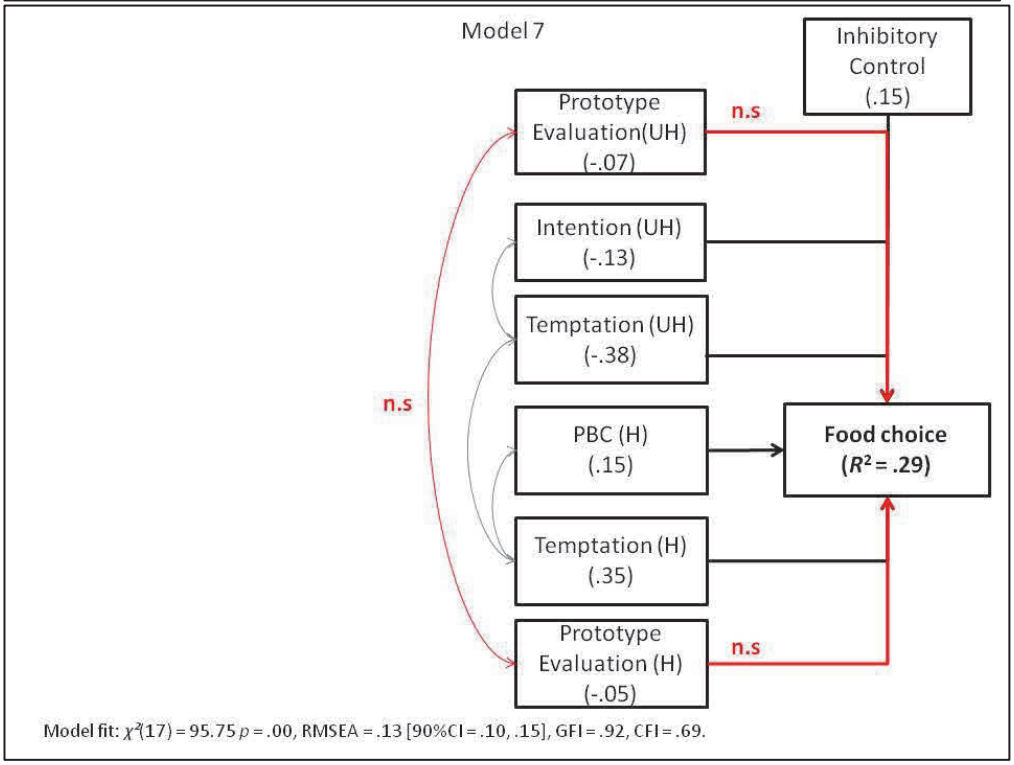
## Appendix H


Model 4
Inhibitory Control (.15)
PBC (UH) (-.05)
n.s
Intention (UH) (-.12)
Temptation (UH) (-.39)
Intention (H) (.08)
n.s
Food choice ($R^2$ = .27)
Temptation (H) (.34)
PBC (H) (.11)
Model fit: $\chi^2(16) = 168.68$ $p = .00$, RMSEA = .18 [90%CI = .16, .21], GFI = .88, CFI = .59.

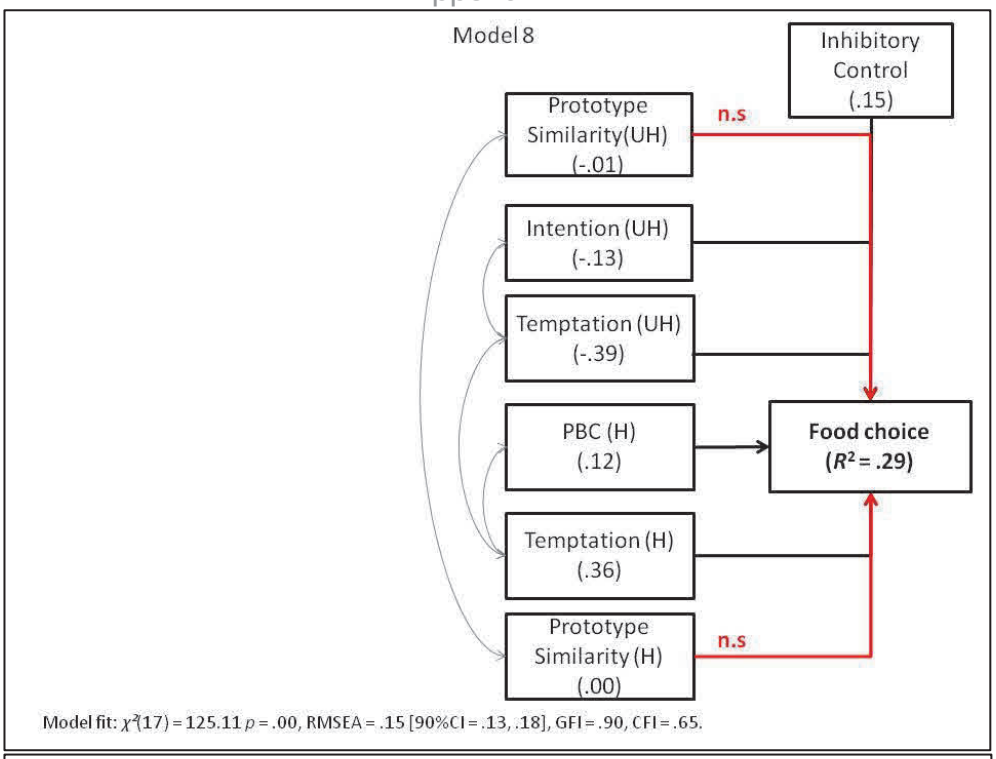

Model 5
Inhibitory Control (.15)
PBC (UH) (-.05)
n.s
Intention (UH) (-.11)
P=.54
Temptation (UH) (-.38)
Intention (H) (.07)
n.s
Food choice ($R^2$ = .27)
Temptation (H) (.34)
PBC (H) (.11)
P=.55
Model fit: $\chi^2(14) = 68.928$ $p = .00$, RMSEA = .12 [90%CI = .09, .15], GFI = .94, CFI = .85.

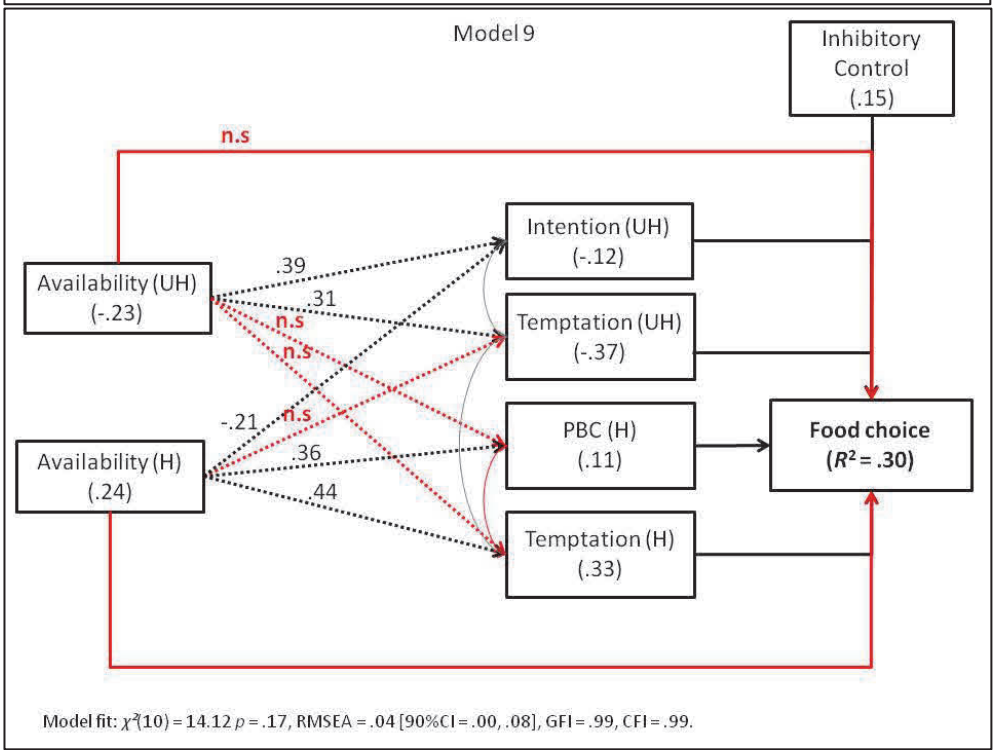
## Appendix H


Model 6
Inhibitory Control (.15)
Intention (UH) (-.14)
Temptation (UH) (-.39)
Food choice ($R^2$ = .29)
Temptation (H) (.36)
PBC (H) (.12)
Model fit: $\chi^2(7) = 20.43$ $p = .005$, RMSEA = .08 [90%CI = .04, .13], GFI = .98, CFI = .93.

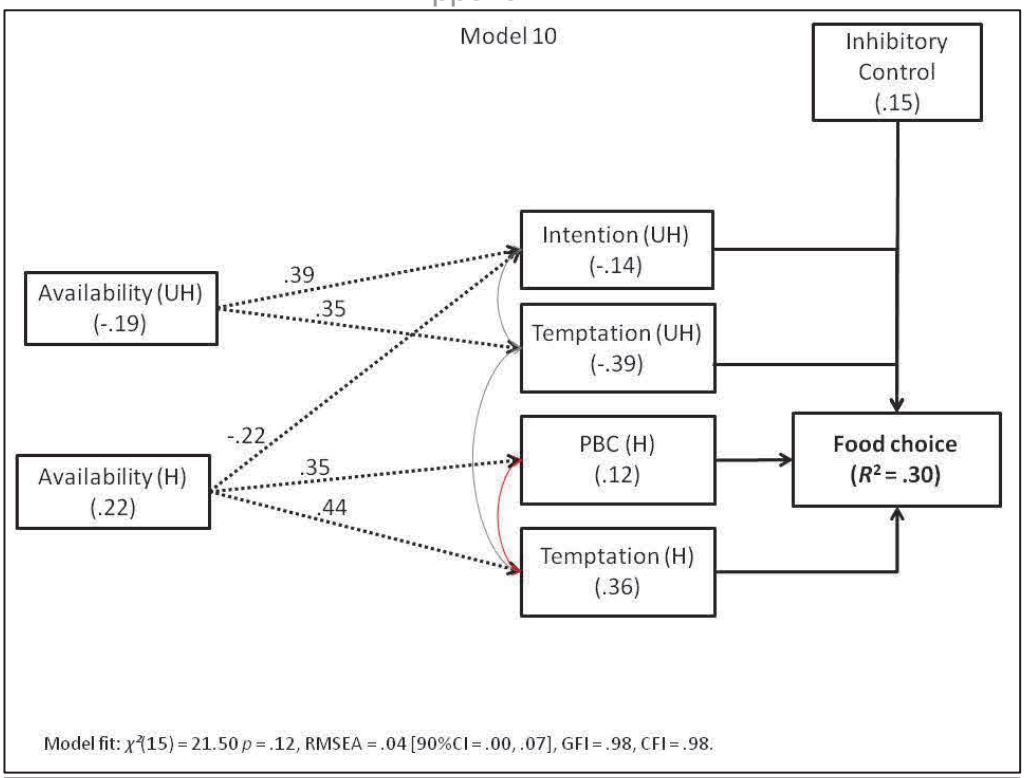

Model 7
Inhibitory Control (.15)
Prototype Evaluation(UH) (-.07)
n.s
Intention (UH) (-.13)
Temptation (UH) (-.38)
n.s
PBC (H) (.15)
Food choice ($R^2$ = .29)
Temptation (H) (.35)
Prototype Evaluation (H) (-.05)
n.s
Model fit: $\chi^2(17) = 95.75$ $p = .00$, RMSEA = .13 [90%CI = .10, .15], GFI = .92, CFI = .69.

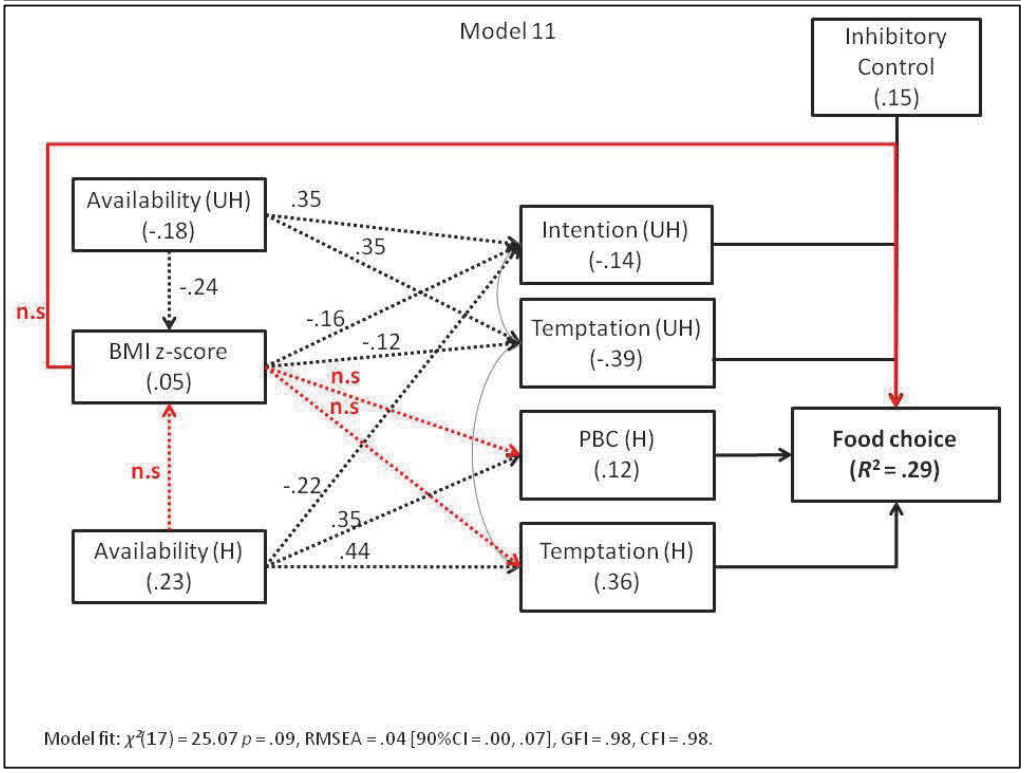
## Appendix H


Model 8
Inhibitory Control (.15)
Prototype Similarity(UH) (-.01)
n.s
Intention (UH) (-.13)
Temptation (UH) (-.39)
PBC (H) (.12)
Food choice ($R^2$ = .29)
Temptation (H) (.36)
Prototype Similarity (H) (.00)
n.s
Model fit: $\chi^2(17) = 125.11$ $p = .00$, RMSEA = .15 [90%CI = .13, .18], GFI = .90, CFI = .65.

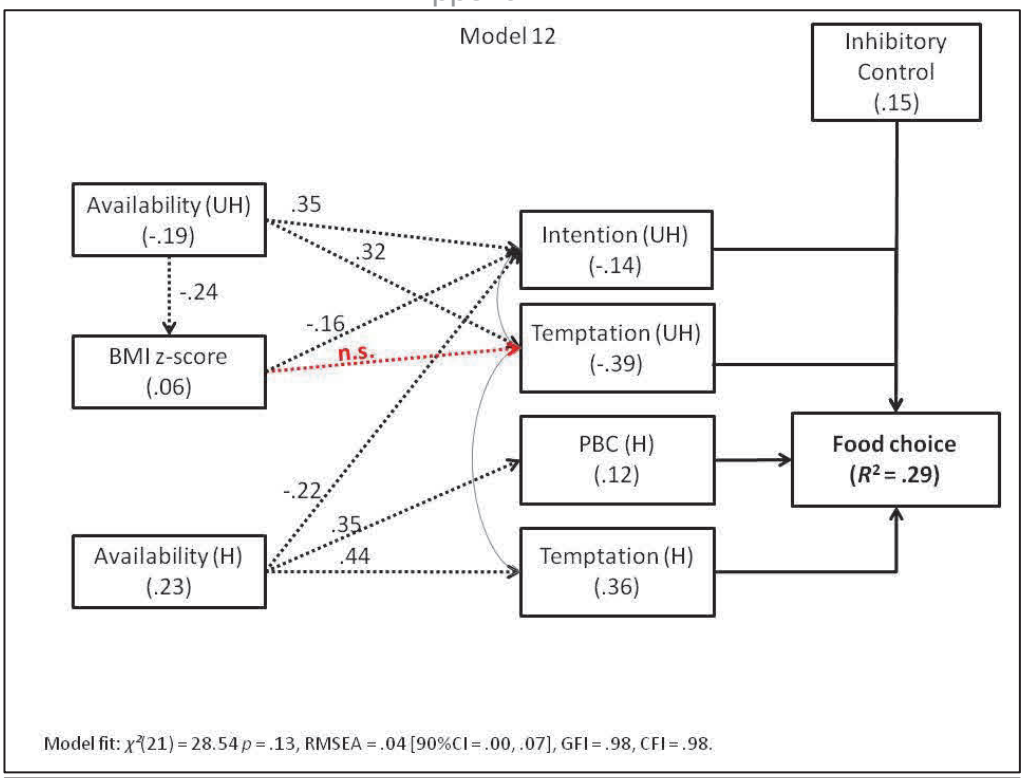

Model 9
Inhibitory Control (.15)
n.s
Availability (UH) (-.23)
Availability (H) (.24)
.39
.31
n.s
n.s
-.21
n.s
.36
.44
Intention (UH) (-.12)
Temptation (UH) (-.37)
PBC (H) (.11)
Temptation (H) (.33)
Food choice ($R^2$ = .30)
Model fit: $\chi^2(10) = 14.12$ $p = .17$, RMSEA = .04 [90%CI = .00, .08], GFI = .99, CFI = .99.

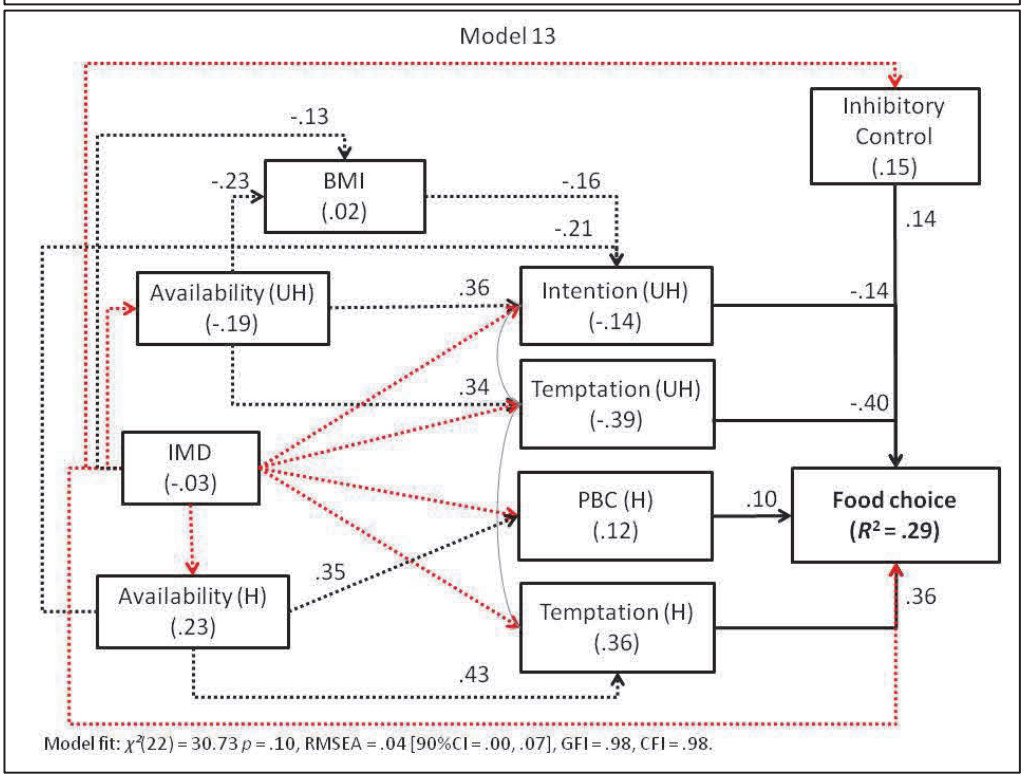
## Appendix H


Model 10
Inhibitory Control (.15)
Intention (UH) (-.14)
Availability (UH) (-.19)
.39
.35
Temptation (UH) (-.39)
-.22
PBC (H) (.12)
Food choice ($R^2$ = .30)
Availability (H) (.22)
.35
.44
Temptation (H) (.36)
Model fit: $\chi^2(15) = 21.50$ $p = .12$, RMSEA = .04 [90%CI = .00, .07], GFI = .98, CFI = .98.

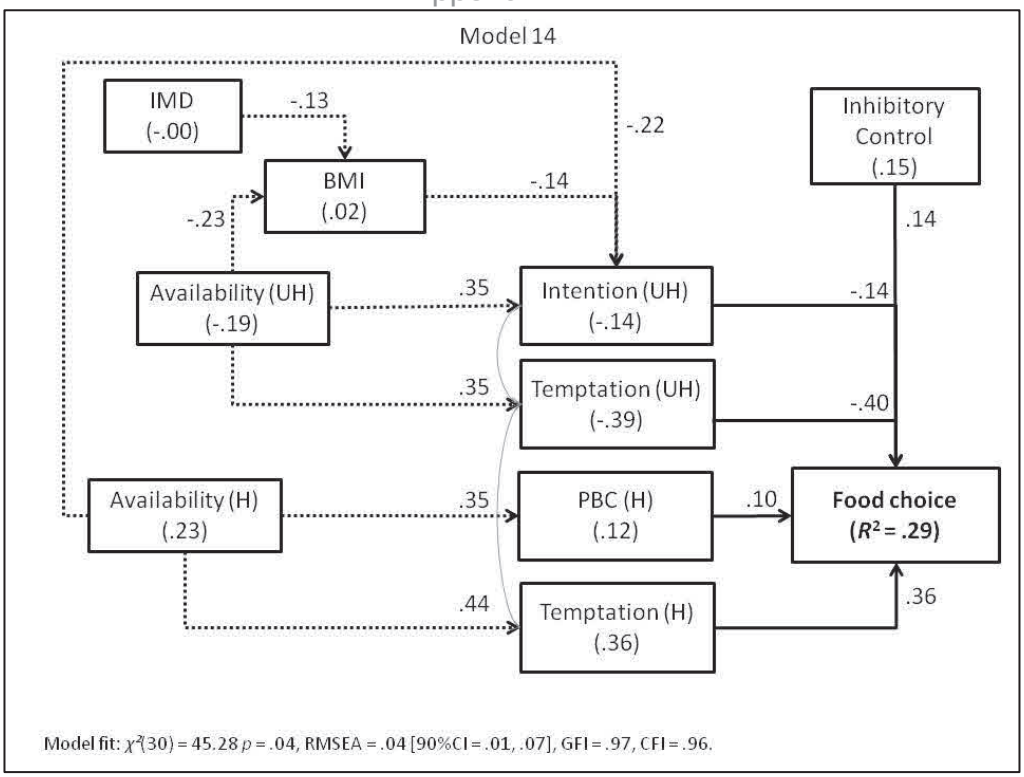

Model 11
Inhibitory Control (.15)
Availability (UH) (-.18)
.35
.35
Intention (UH) (-.14)
-.24
n.s
-.16
-.12
Temptation (UH) (-.39)
BMI z-score (.05)
n.s
n.s
PBC (H) (.12)
Food choice ($R^2$ = .29)
n.s
-.22
.35
Availability (H) (.23)
.44
Temptation (H) (.36)
Model fit: $\chi^2(17) = 25.07$ $p = .09$, RMSEA = .04 [90%CI = .00, .07], GFI = .98, CFI = .98.

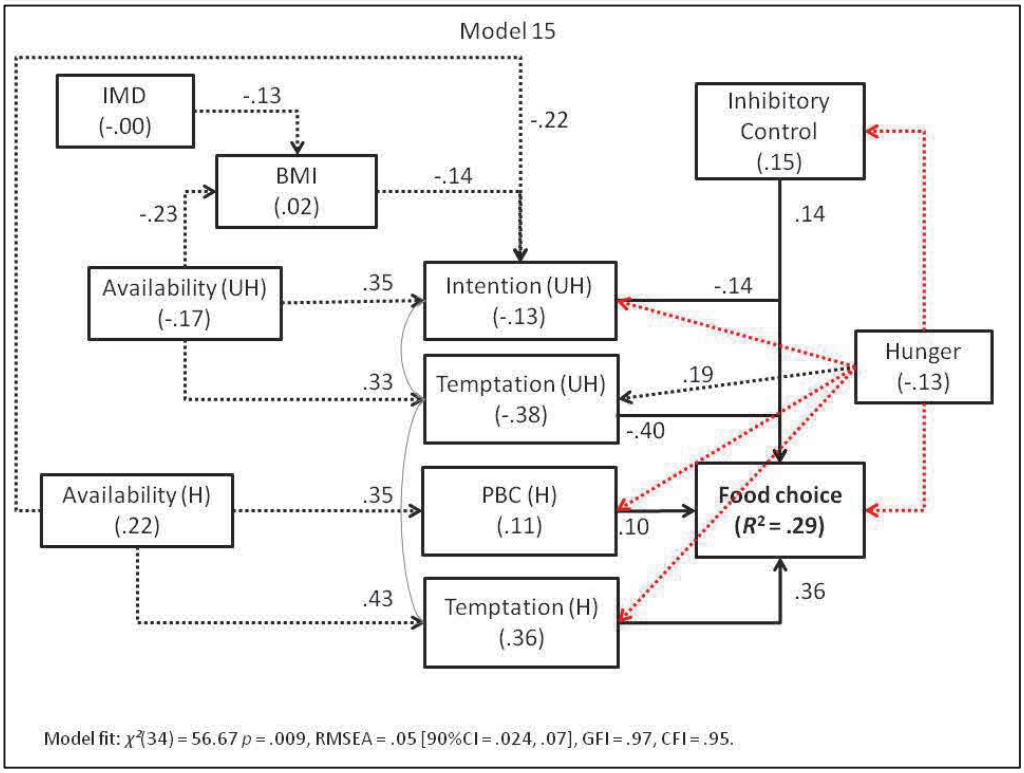
## Appendix H


Model 12
Inhibitory Control (.15)
Availability (UH) (-.19)
.35
.32
-.24
-.16
n.s.
BMI z-score (.06)
Intention (UH) (-.14)
Temptation (UH) (-.39)
PBC (H) (.12)
Food choice ($R^2$ = .29)
-.22
.35
.44
Availability (H) (.23)
Temptation (H) (.36)
Model fit: $\chi^2(21) = 28.54$ $p = .13$, RMSEA = .04 [90%CI = .00, .07], GFI = .98, CFI = .98.

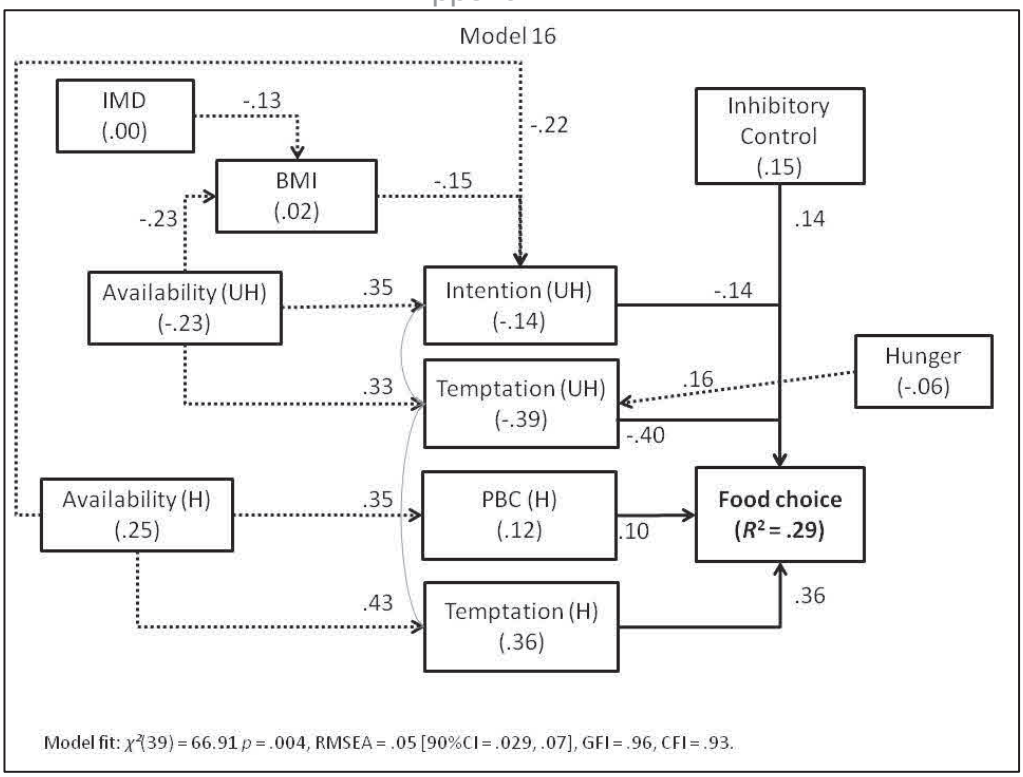

Model 13
Inhibitory Control (.15)
-.13
-.23
BMI (.02)
-.16
-.21
.14
Availability (UH) (-.19)
.36
Intention (UH) (-.14)
-.14
.34
Temptation (UH) (-.39)
-.40
IMD (-.03)
PBC (H) (.12)
.10
Food choice ($R^2$ = .29)
.35
Availability (H) (.23)
Temptation (H) (.36)
.36
.43
Model fit: $\chi^2(22) = 30.73$ $p = .10$, RMSEA = .04 [90%CI = .00, .07], GFI = .98, CFI = .98.

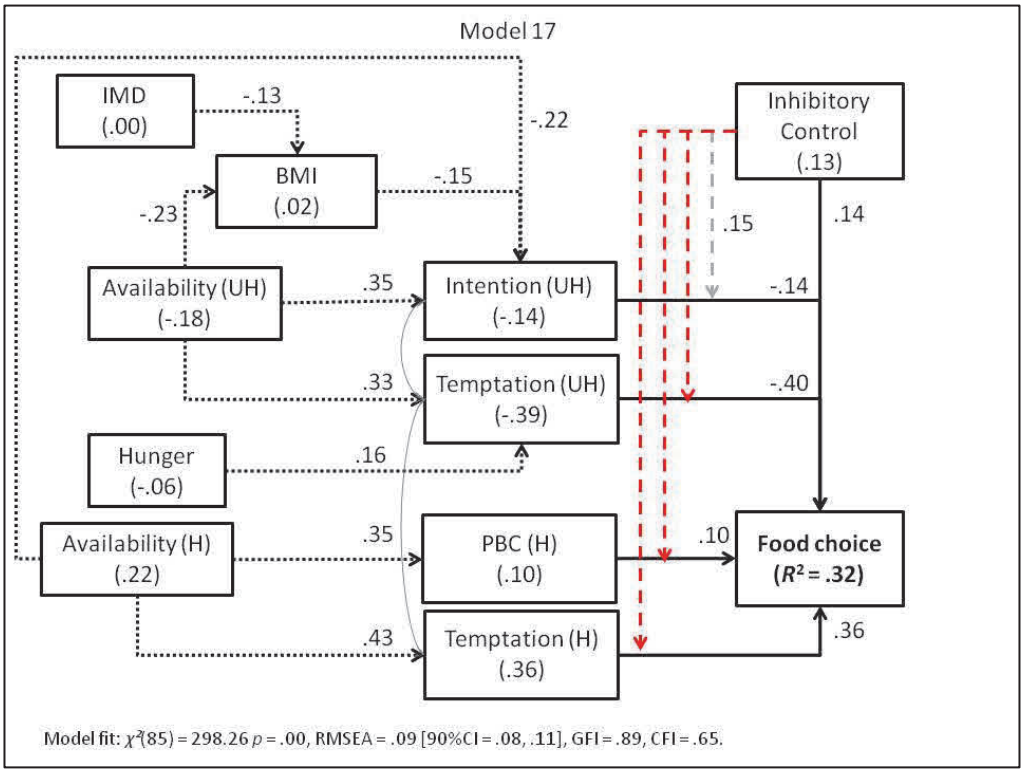
## Appendix H


Model 14
IMD (-.00)
-.13
BMI (.02)
-.23
-.22
-.14
Inhibitory Control (.15)
.14
Availability (UH) (-.19)
.35
Intention (UH) (-.14)
-.14
.35
Temptation (UH) (-.39)
-.40
Availability (H) (.23)
.35
PBC (H) (.12)
.10
Food choice ($R^2$ = .29)
.44
Temptation (H) (.36)
.36
Model fit: $\chi^2(30) = 45.28$ $p = .04$, RMSEA = .04 [90%CI = .01, .07], GFI = .97, CFI = .96.

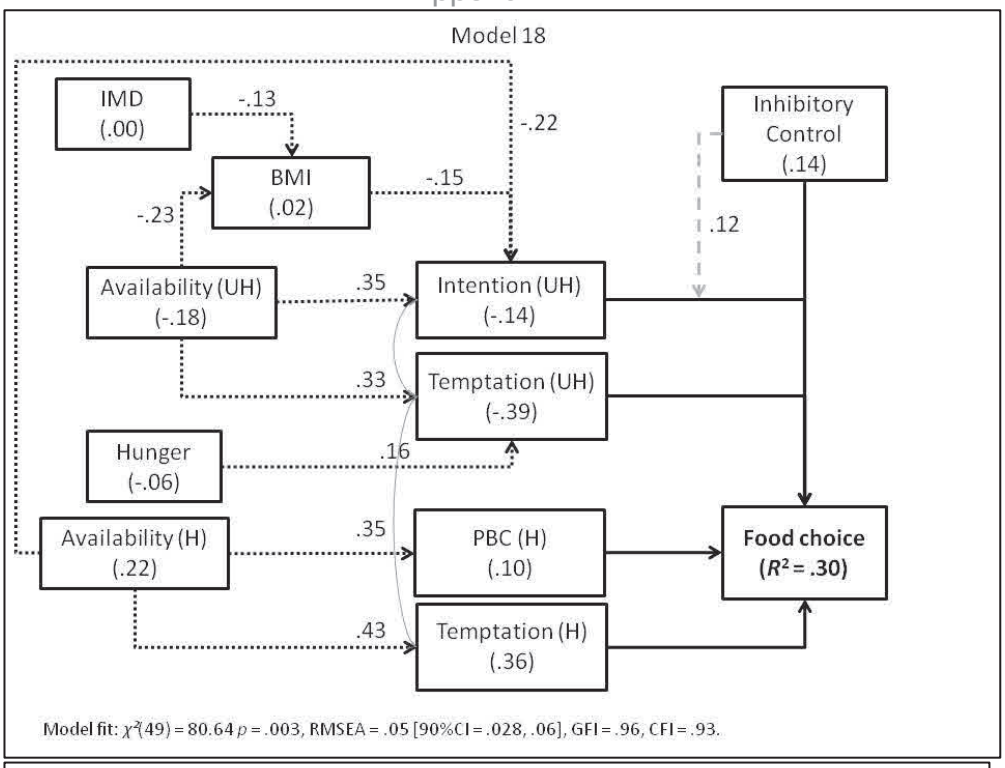

Model 15
IMD (-.00)
-.13
BMI (.02)
-.23
-.22
-.14
Inhibitory Control (.15)
.14
Availability (UH) (-.17)
.35
Intention (UH) (-.13)
-.14
Hunger (-.13)
.33
Temptation (UH) (-.38)
.19
-.40
Availability (H) (.22)
.35
PBC (H) (.11)
.10
Food choice ($R^2$ = .29)
.43
Temptation (H) (.36)
.36
Model fit: $\chi^2(34) = 56.67$ $p = .009$, RMSEA = .05 [90%CI = .024, .07], GFI = .97, CFI = .95.

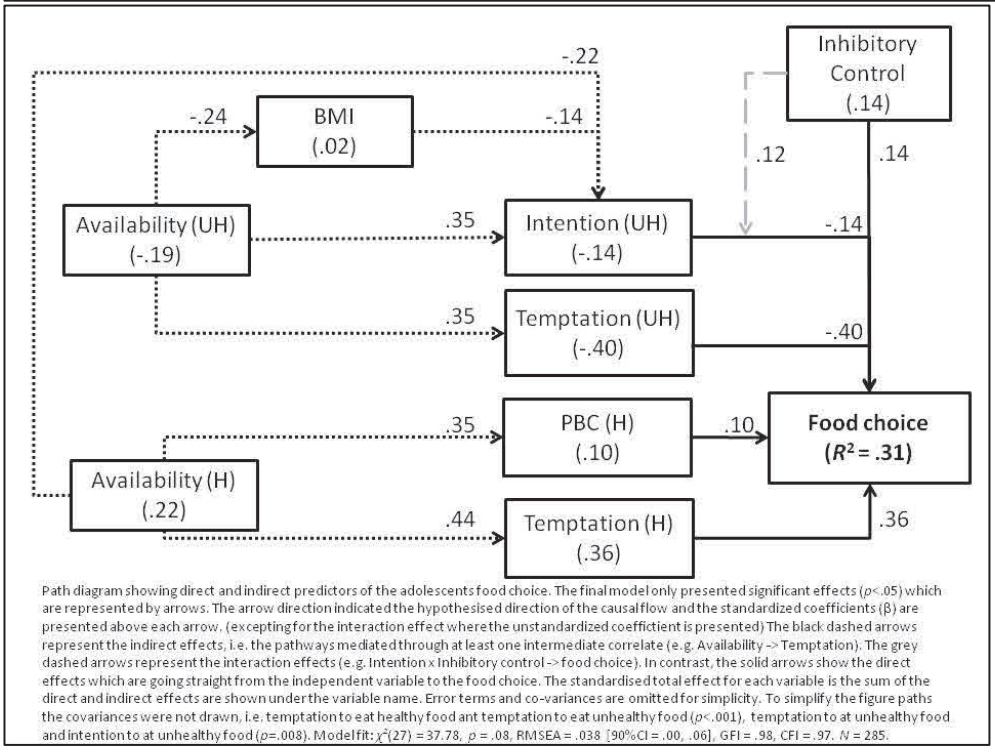
## Appendix H


Model 16
IMD (.00)
-.13
-.22
Inhibitory Control (.15)
BMI (.02)
-.15
-.23
.14
Availability (UH) (-.23)
.35
Intention (UH) (-.14)
-.14
Hunger (-.06)
.33
Temptation (UH) (-.39)
.16
-.40
Availability (H) (.25)
.35
PBC (H) (.12)
.10
Food choice ($R^2$ = .29)
.43
Temptation (H) (.36)
.36
Model fit: $\chi^2(39) = 66.91$ $p = .004$, RMSEA = .05 [90%CI = .029, .07], GFI = .96, CFI = .93.


Model 17
IMD (.00)
-.13
-.22
Inhibitory Control (.13)
BMI (.02)
-.15
-.23
.15
.14
Availability (UH) (-.18)
.35
Intention (UH) (-.14)
-.14
.33
Temptation (UH) (-.39)
-.40
Hunger (-.06)
.16
Availability (H) (.22)
.35
PBC (H) (.10)
.10
Food choice ($R^2$ = .32)
.43
Temptation (H) (.36)
.36
Model fit: $\chi^2(85) = 298.26$ $p = .00$, RMSEA = .09 [90%CI = .08, .11], GFI = .89, CFI = .65.

## Appendix H

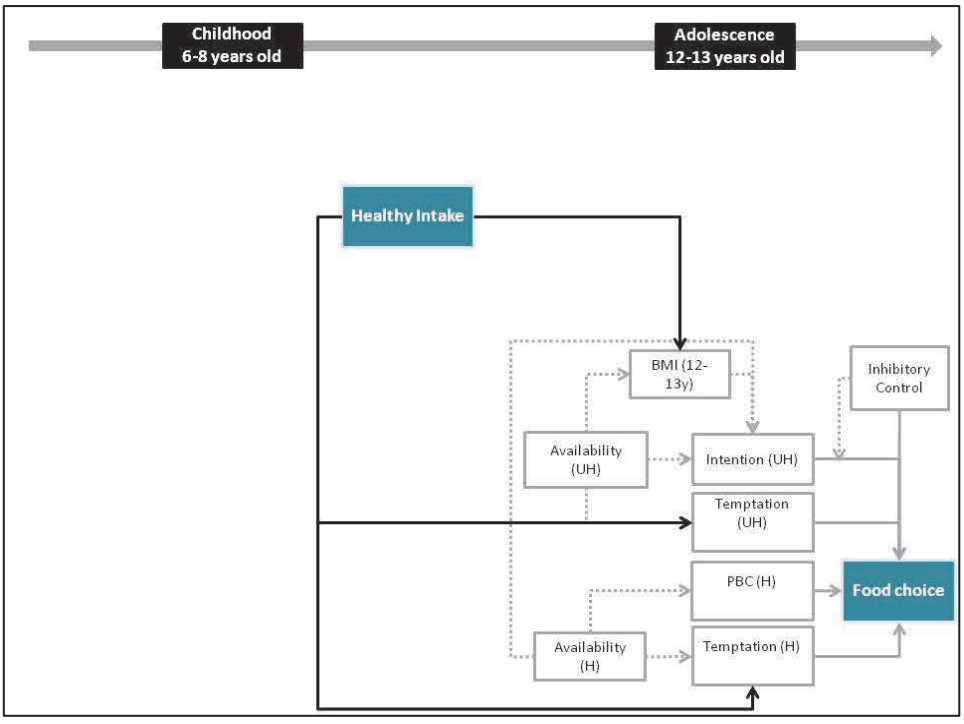


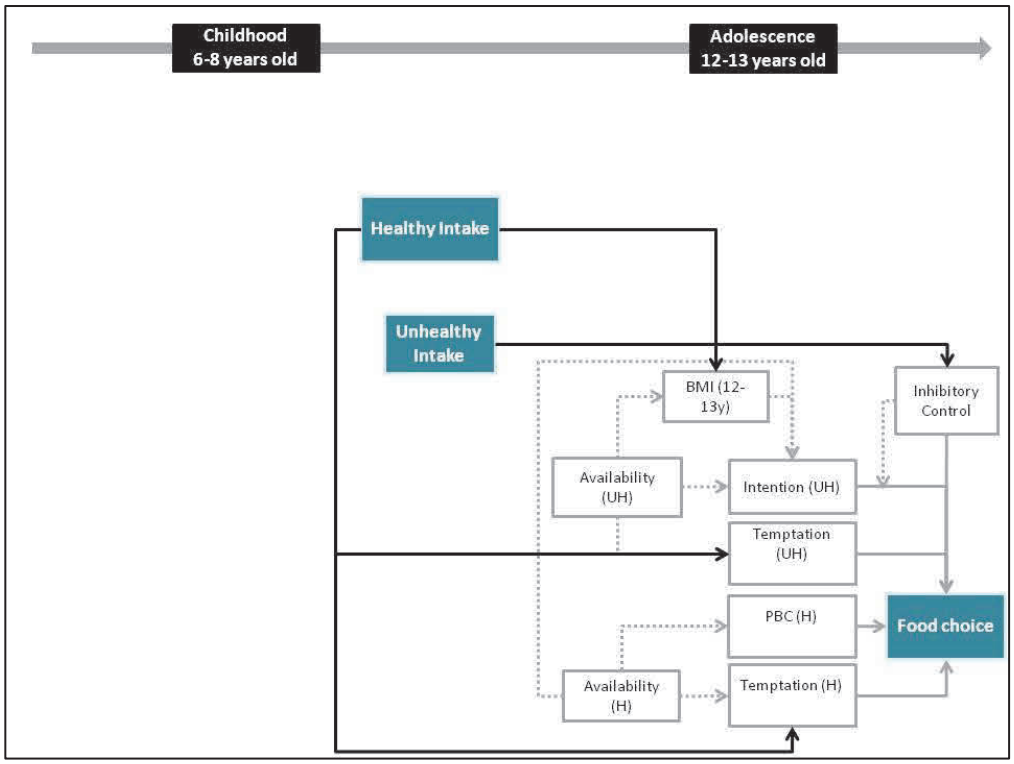

Path diagram showing direct and indirect predictors of the adolescents food choice. The final model only presented significant effects ($p$<.05) which are represented by arrows. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients (β) are presented above each arrow. (excepting for the interaction effect where the unstandardized coefficient is presented) The black dashed arrows represent the indirect effects, i.e. the pathways mediated through at least one intermediate correlate (e.g. Availability -> Temptation). The grey dashed arrows represent the interaction effects (e.g. Intention x Inhibitory control -> food choice). In contrast, the solid arrows show the direct effects which are going straight from the independent variable to the food choice. The standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name. Error terms and co-variances are omitted for simplicity. To simplify the figure paths the covariances were not drawn, i.e. temptation to eat healthy food ant temptation to eat unhealthy food ($p$<.001), temptation to at unhealthy food and intention to at unhealthy food ($p$=.008). Model fit: $\chi^2(27) = 37.78$, $p = .08$, RMSEA = .038 [90%CI = .00, .06], GFI = .98, CFI = .97. $N$ = 285.

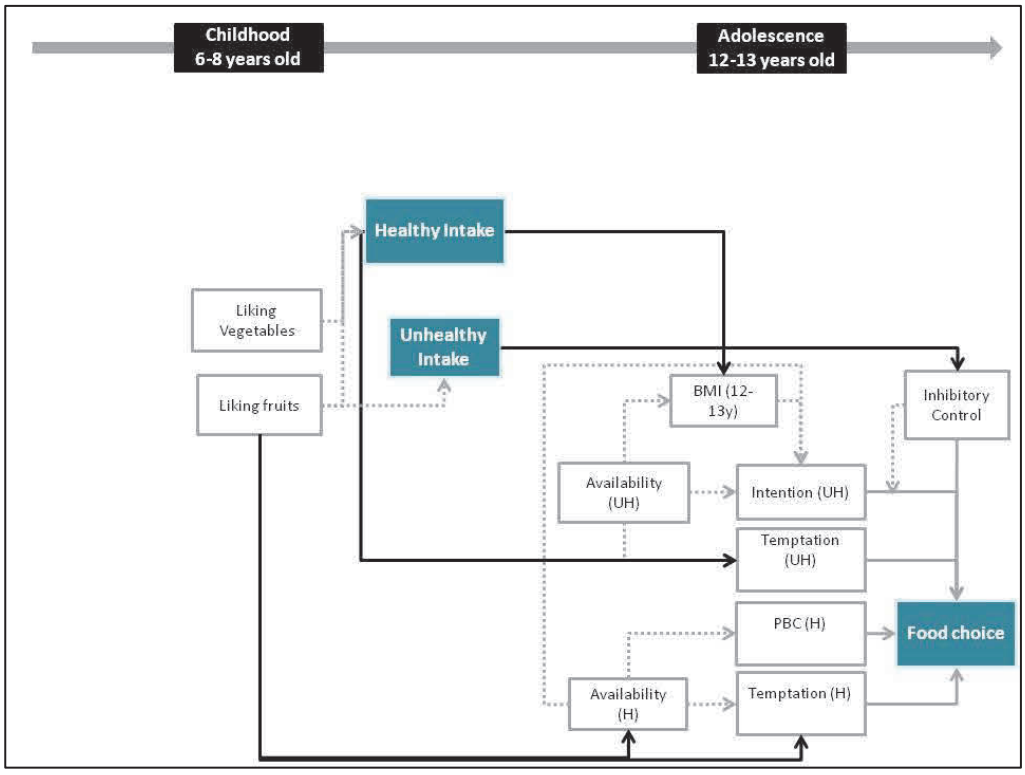
## Appendix I

- Model of childhood's eating behaviours and of adolescent's eating behaviours are based on the results of the chapter 2.1 and 3.3, respectively. Relationships within each of the models are represented by grey arrows.
- Each variable from the childhood model (left side) was related to all variables of the adolescence model (right side). However, only significant effects ($p<.05$) which are represented by black arrows were drawn in order to simplify the diagrams
- Path diagrams showing direct and indirect on adolescents food choice. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients ($\beta$) are presented above each arrow.
- In the final model, the standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name.

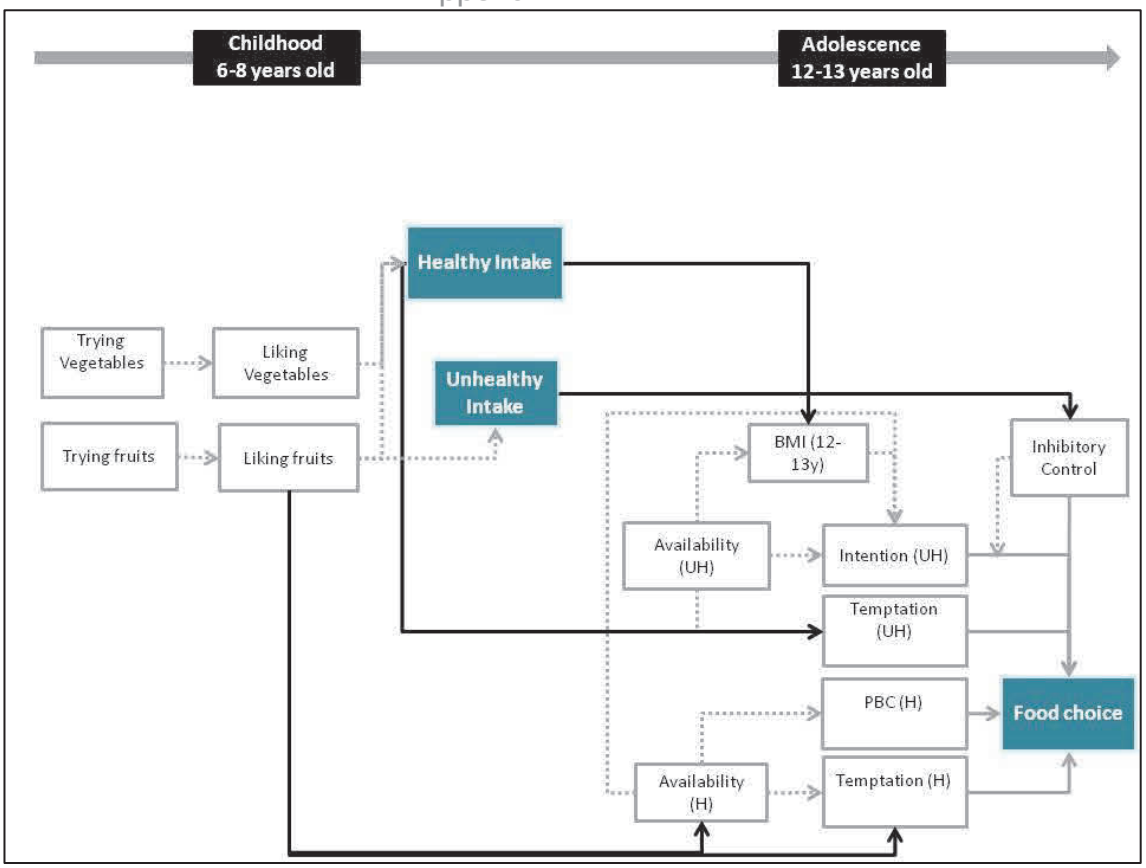


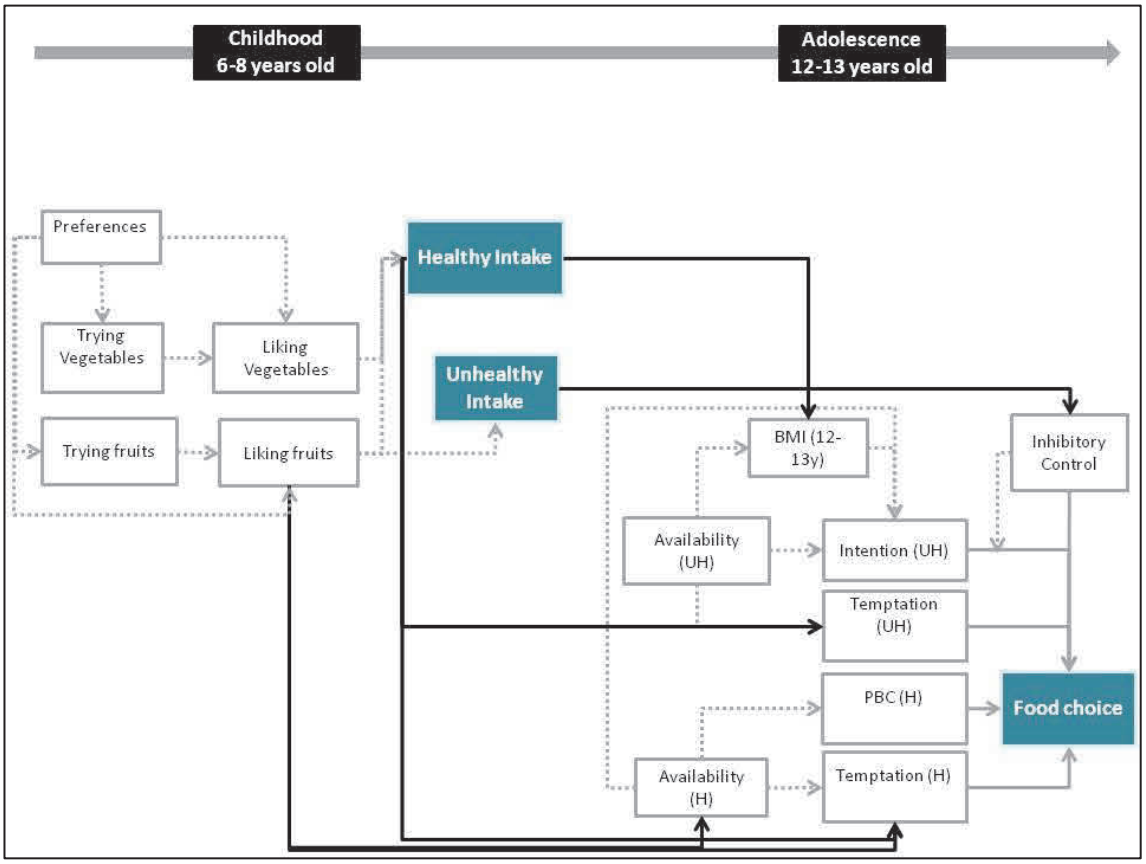
Appendix I


Childhood
6-8 years old
Adolescence
12-13 years old
Healthy Intake
Unhealthy Intake
BMI (12-13y)
Inhibitory Control
Availability (UH)
Intention (UH)
Temptation (UH)
PBC (H)
Food choice
Availability (H)
Temptation (H)

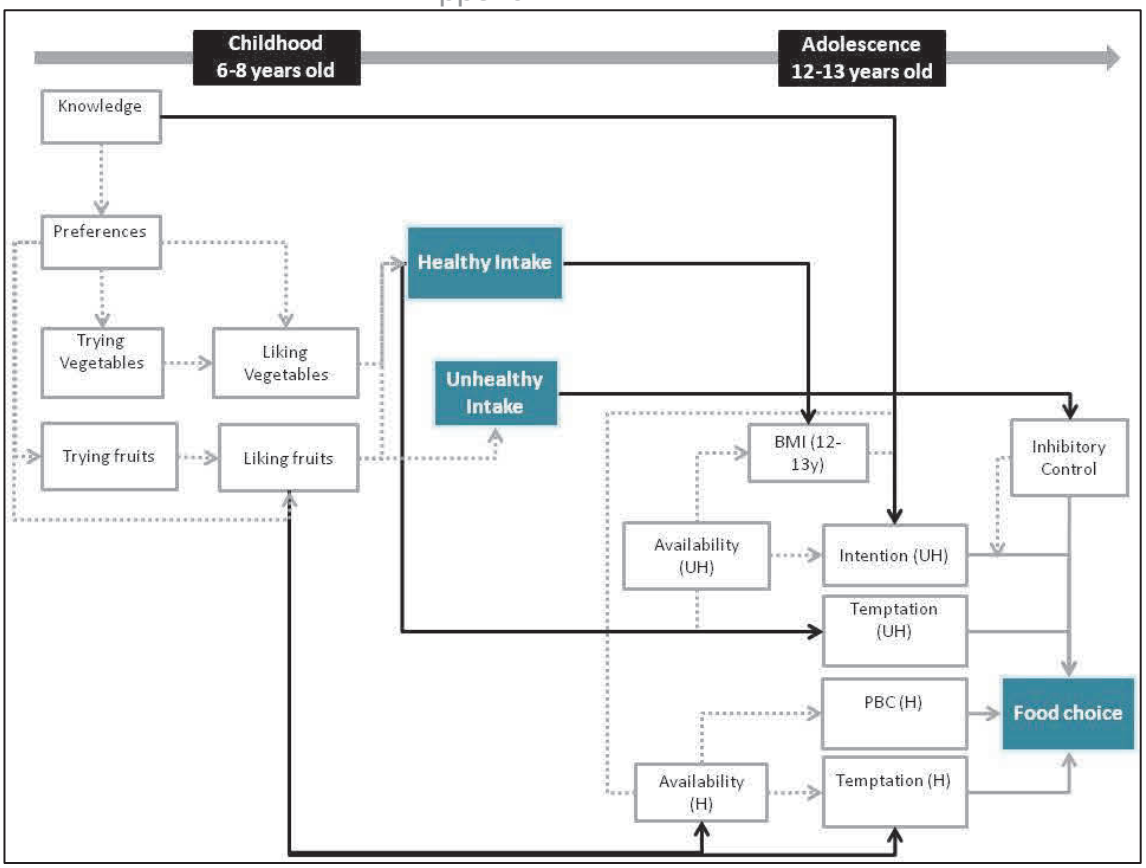

Childhood
6-8 years old
Adolescence
12-13 years old
Healthy Intake
Liking Vegetables
Unhealthy Intake
Liking fruits
BMI (12-13y)
Inhibitory Control
Availability (UH)
Intention (UH)
Temptation (UH)
PBC (H)
Food choice
Availability (H)
Temptation (H)

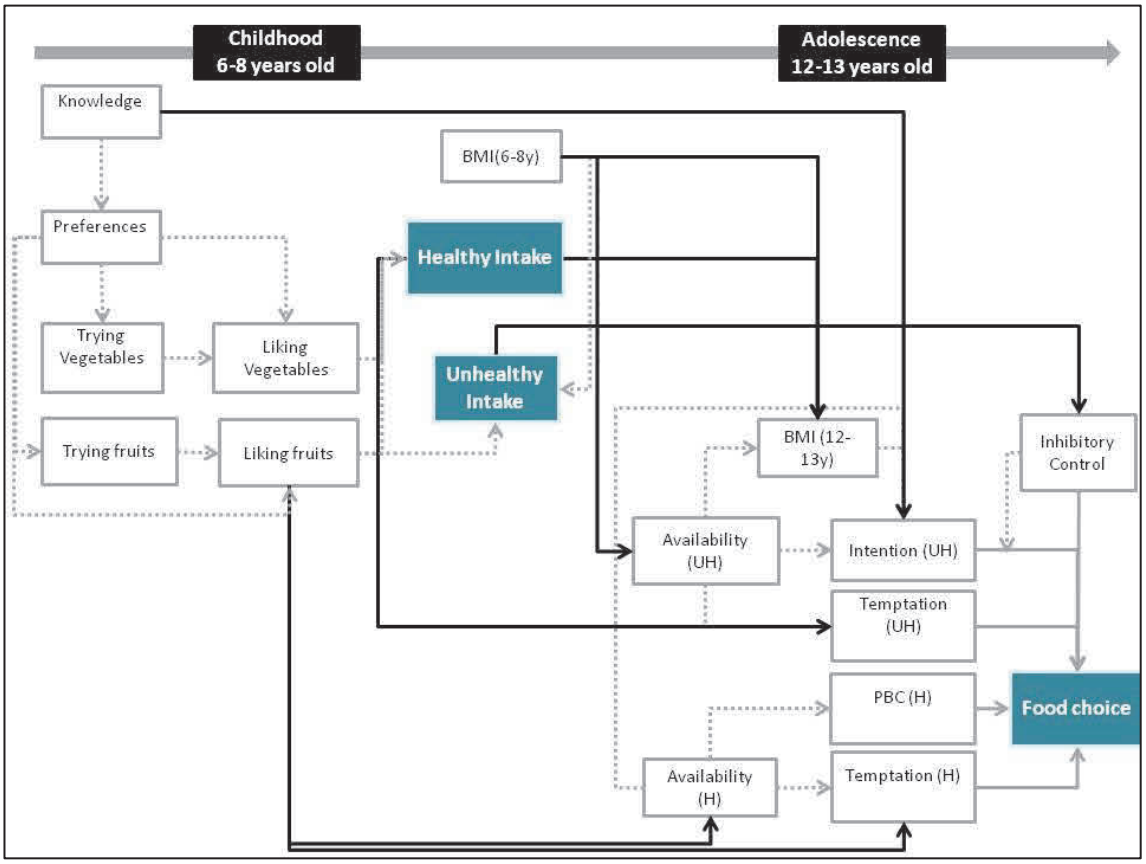
## Appendix I


Childhood
6-8 years old
Adolescence
12-13 years old
Healthy Intake
Unhealthy Intake
Trying Vegetables
Liking Vegetables
Trying fruits
Liking fruits
BMI (12-13y)
Inhibitory Control
Availability (UH)
Intention (UH)
Temptation (UH)
PBC (H)
Food choice
Availability (H)
Temptation (H)

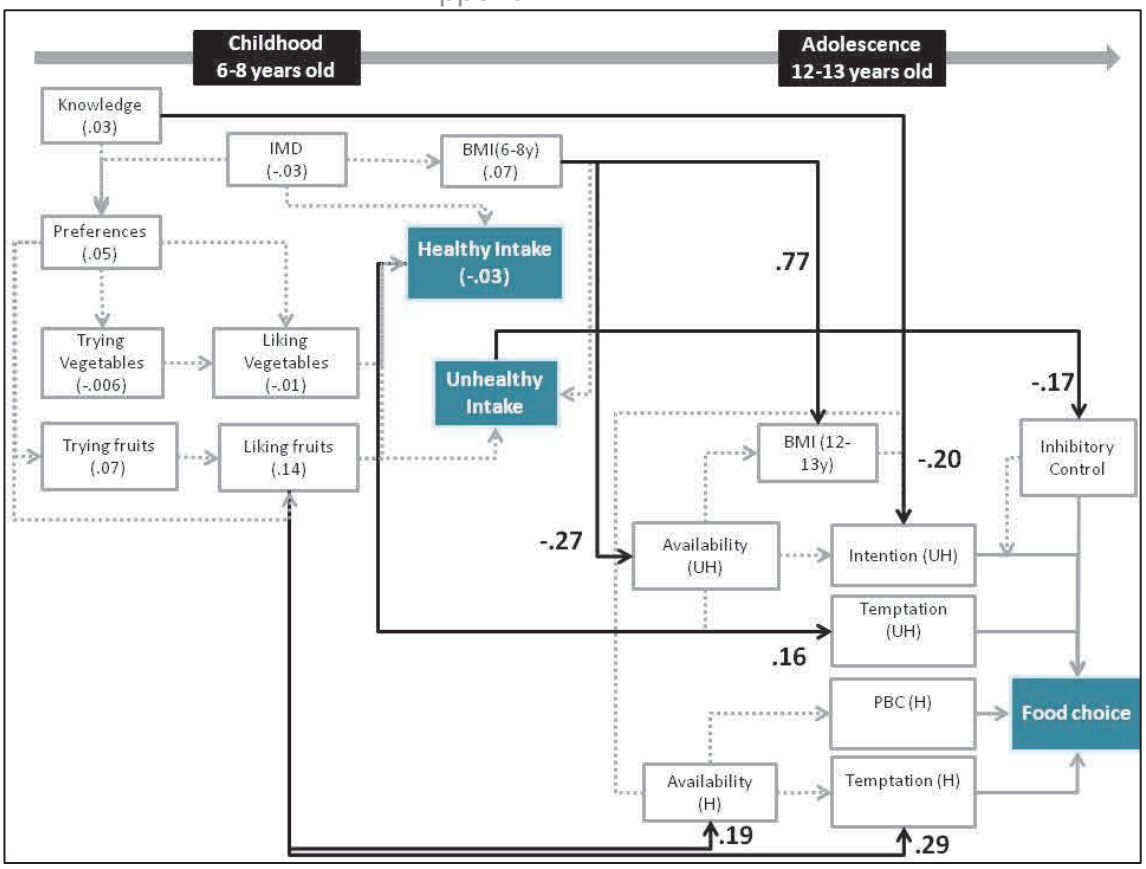

Childhood
6-8 years old
Adolescence
12-13 years old
Preferences
Healthy Intake
Unhealthy Intake
Trying Vegetables
Liking Vegetables
Trying fruits
Liking fruits
BMI (12-13y)
Inhibitory Control
Availability (UH)
Intention (UH)
Temptation (UH)
PBC (H)
Food choice
Availability (H)
Temptation (H)

## Appendix I


Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge
Preferences
Trying Vegetables
Liking Vegetables
Trying fruits
Liking fruits
Healthy Intake
Unhealthy Intake
BMI (12-13y)
Inhibitory Control
Availability (UH)
Intention (UH)
Temptation (UH)
PBC (H)
Food choice
Availability (H)
Temptation (H)

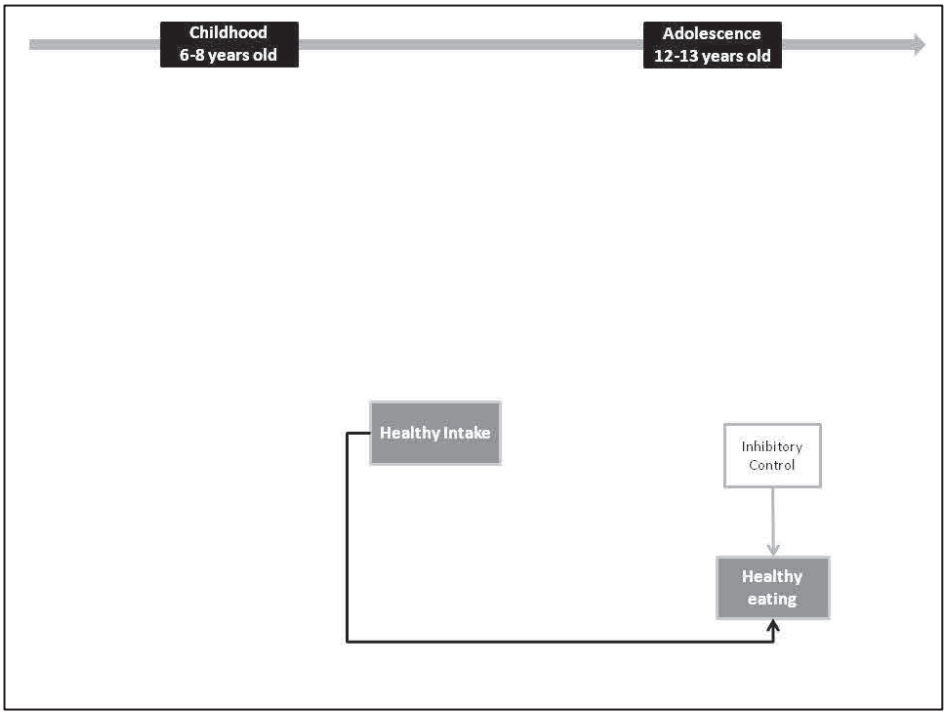

Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge
BMI(6-8y)
Preferences
Healthy Intake
Trying Vegetables
Liking Vegetables
Unhealthy Intake
Trying fruits
Liking fruits
BMI (12-13y)
Inhibitory Control
Availability (UH)
Intention (UH)
Temptation (UH)
PBC (H)
Food choice
Availability (H)
Temptation (H)

## Appendix I

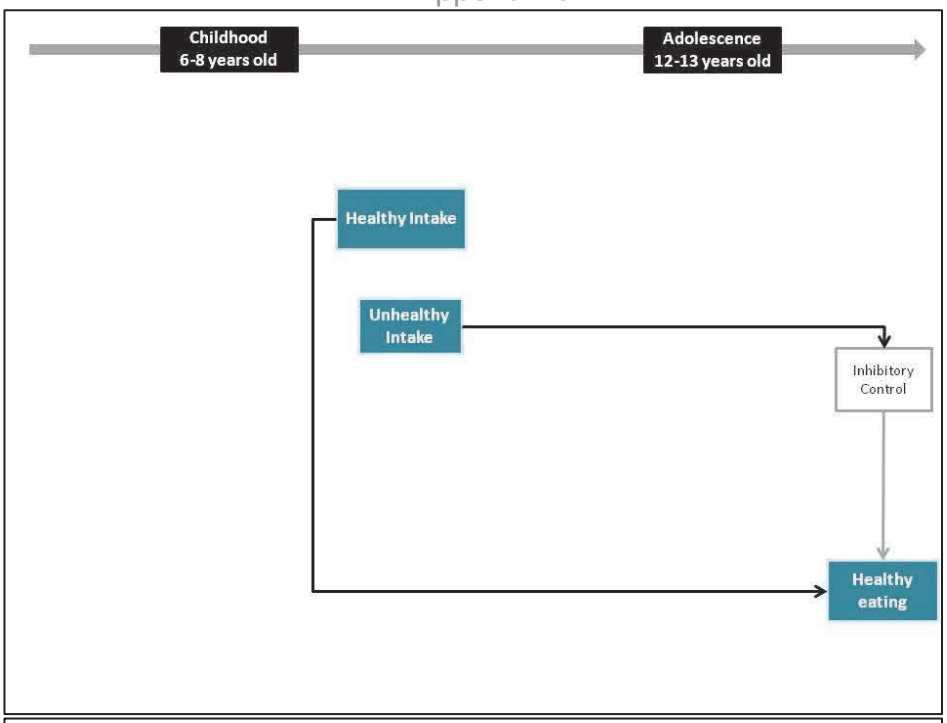

Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge (.03)
IMD (-.03)
BMI(6-8y) (.07)
Preferences (.05)
Healthy Intake (-.03)
.77
Trying Vegetables (-.006)
Liking Vegetables (-.01)
Unhealthy Intake
-.17
Trying fruits (.07)
Liking fruits (.14)
BMI (12-13y)
-.20
Inhibitory Control
-.27
Availability (UH)
Intention (UH)
Temptation (UH)
.16
PBC (H)
Food choice
Availability (H)
Temptation (H)
.19
.29

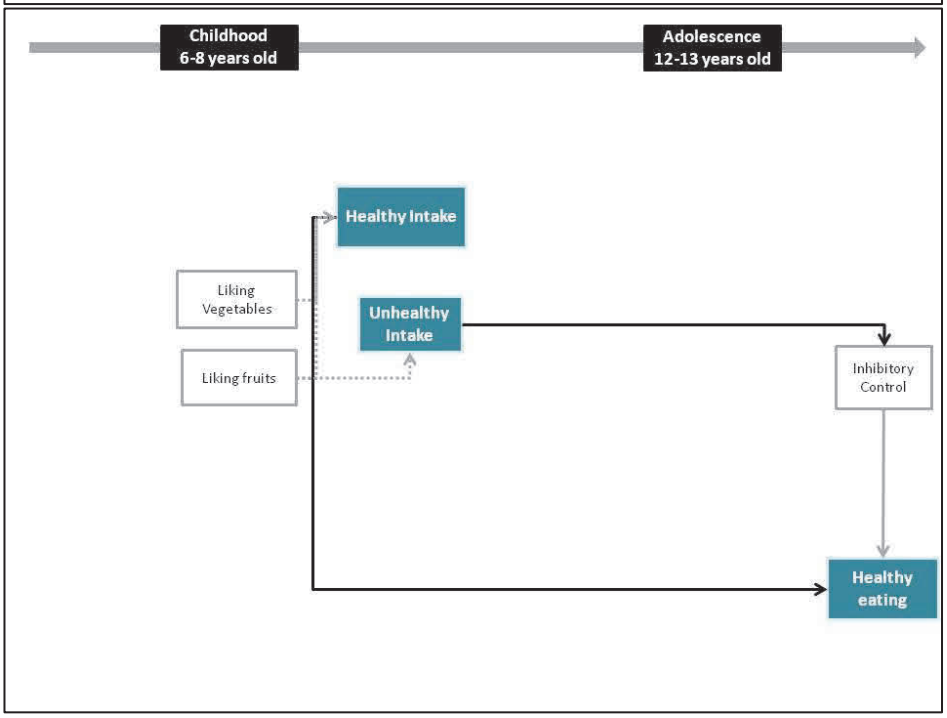
Appendix J

- Model of childhood's eating behaviours and of adolescent's eating behaviours are based on the results of the chapter 2.1 and 3.3, respectively. Relationships within each of the models are represented by grey arrows.
- Each variable from the childhood model (left side) was related to all variables of the adolescence model (right side). However, only significant effects ($p<.05$) which are represented by black arrows were drawn in order to simplify the diagrams
- Path diagrams showing direct and indirect paths on adolescents' healthy eating. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients ($\beta$) are presented above each arrow.
- In the final model, the standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name.

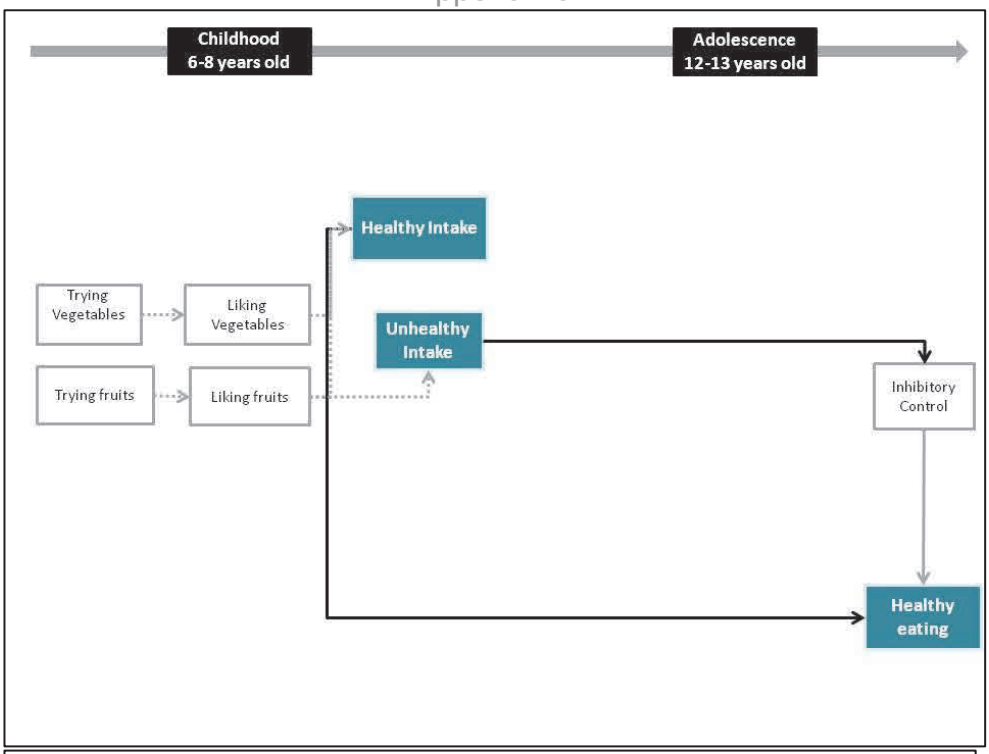


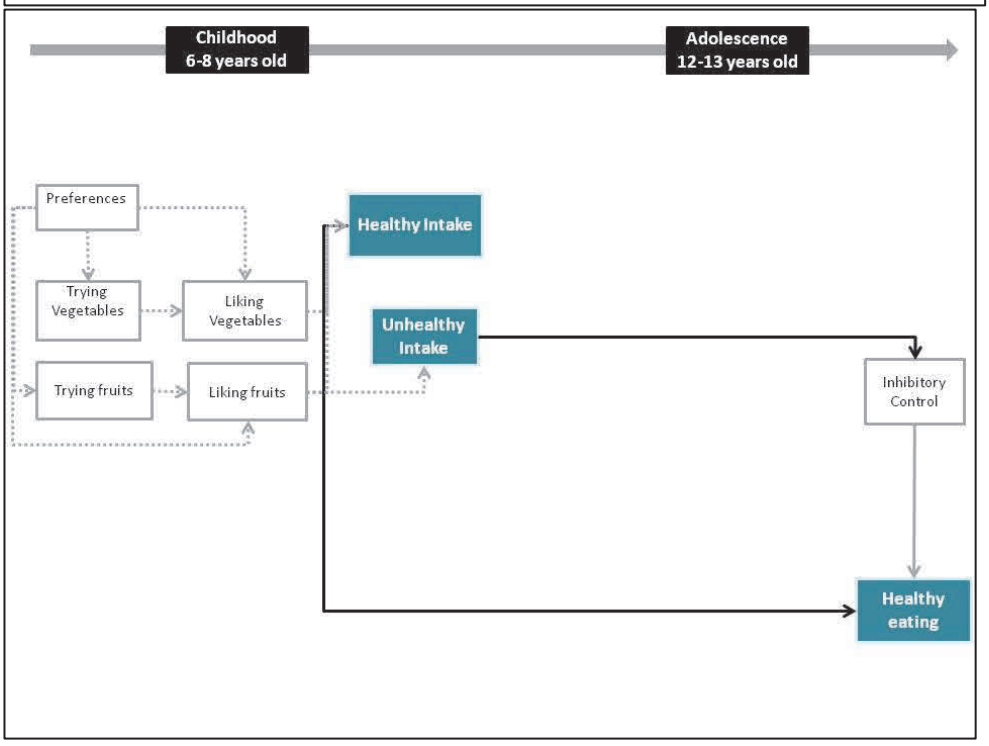
## Appendix J


Childhood
6-8 years old
Adolescence
12-13 years old
Healthy Intake
Unhealthy Intake
Inhibitory Control
Healthy eating

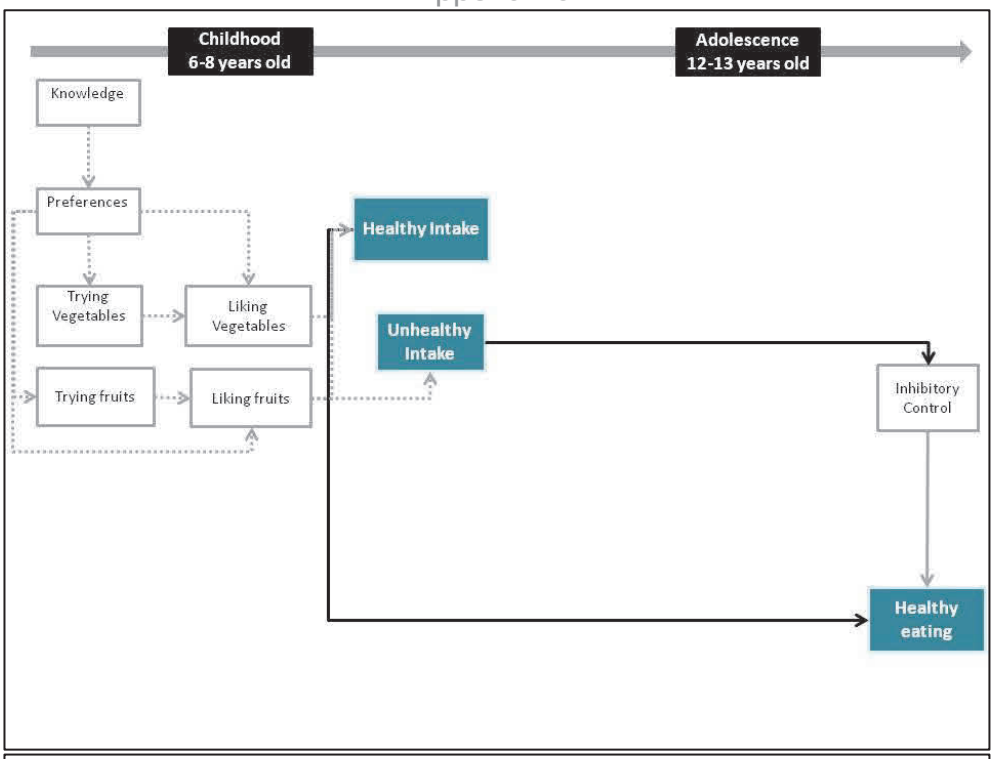

Childhood
6-8 years old
Adolescence
12-13 years old
Healthy Intake
Liking Vegetables
Unhealthy Intake
Liking fruits
Inhibitory Control
Healthy eating

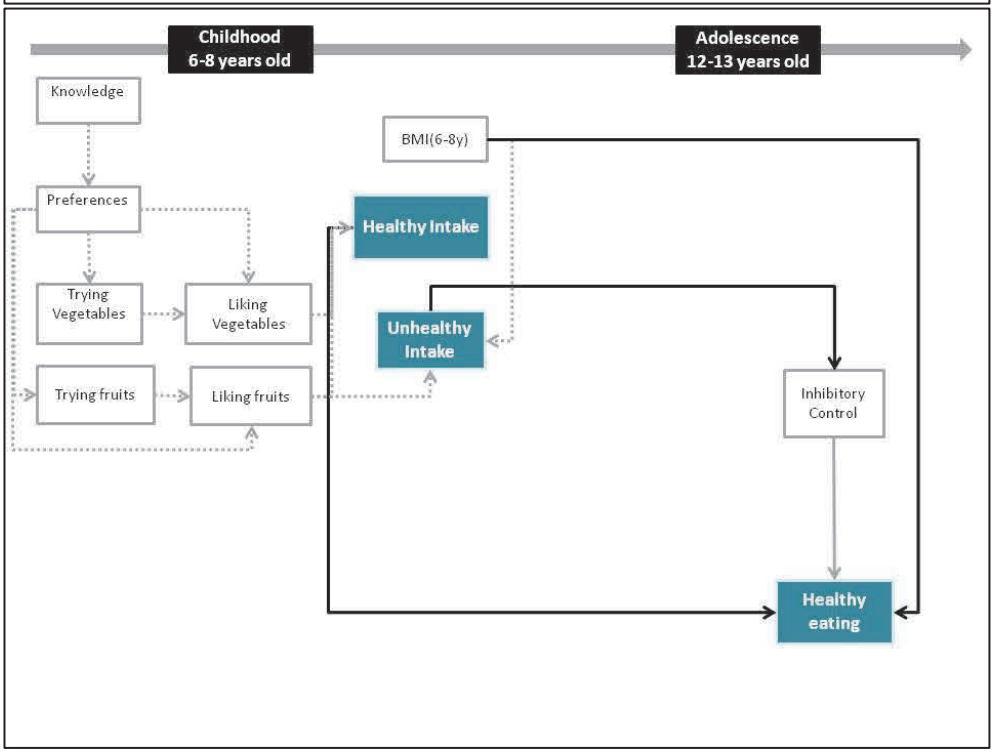
## Appendix J


Childhood
6-8 years old
Adolescence
12-13 years old
Healthy Intake
Trying Vegetables
Liking Vegetables
Unhealthy Intake
Trying fruits
Liking fruits
Inhibitory Control
Healthy eating

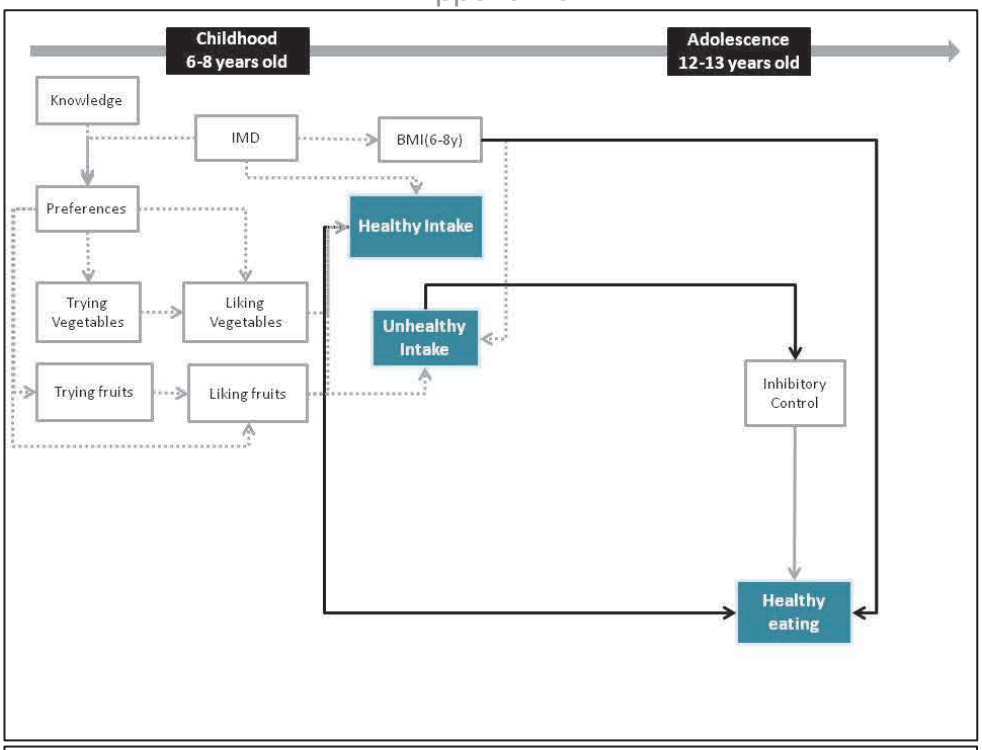

Childhood
6-8 years old
Adolescence
12-13 years old
Preferences
Healthy Intake
Trying Vegetables
Liking Vegetables
Unhealthy Intake
Trying fruits
Liking fruits
Inhibitory Control
Healthy eating

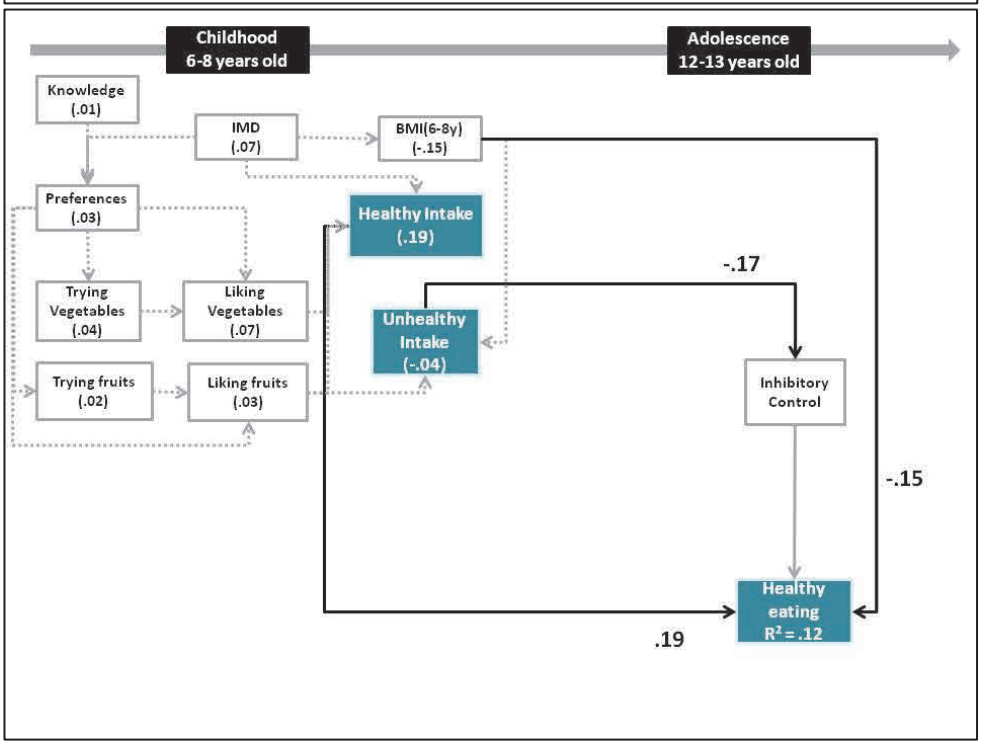
# Appendix J


Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge
Preferences
Trying Vegetables
Liking Vegetables
Trying fruits
Liking fruits
Healthy Intake
Unhealthy Intake
Inhibitory Control
Healthy eating


Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge
BMI(6-8y)
Preferences
Trying Vegetables
Liking Vegetables
Trying fruits
Liking fruits
Healthy Intake
Unhealthy Intake
Inhibitory Control
Healthy eating

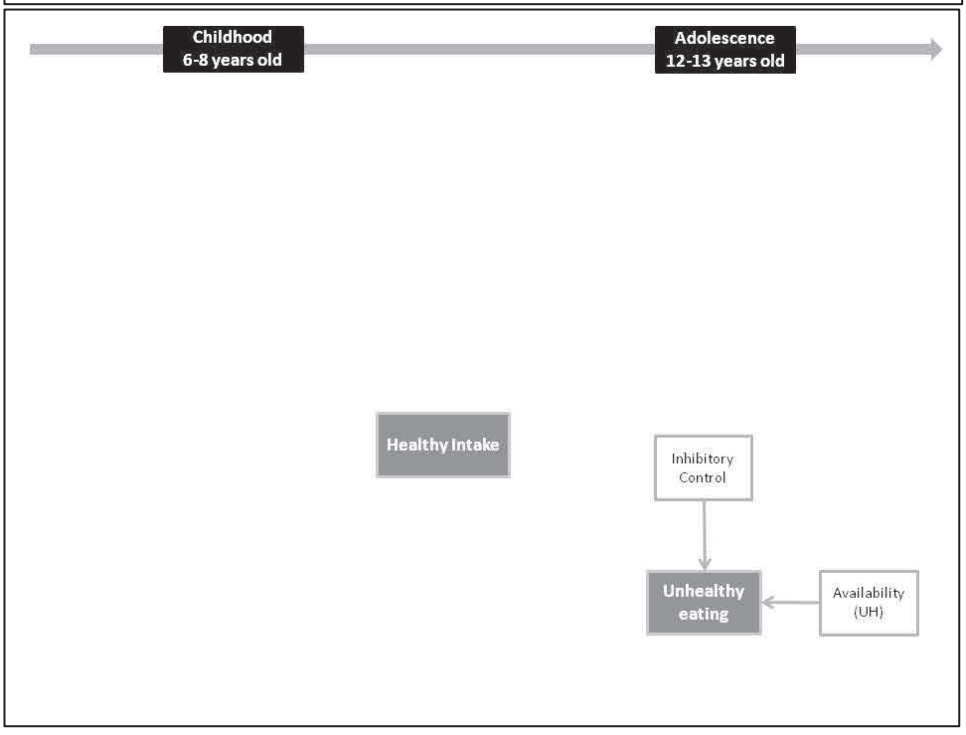
## Appendix J


Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge
IMD
BMI(6-8y)
Preferences
Healthy Intake
Trying Vegetables
Liking Vegetables
Unhealthy Intake
Trying fruits
Liking fruits
Inhibitory Control
Healthy eating

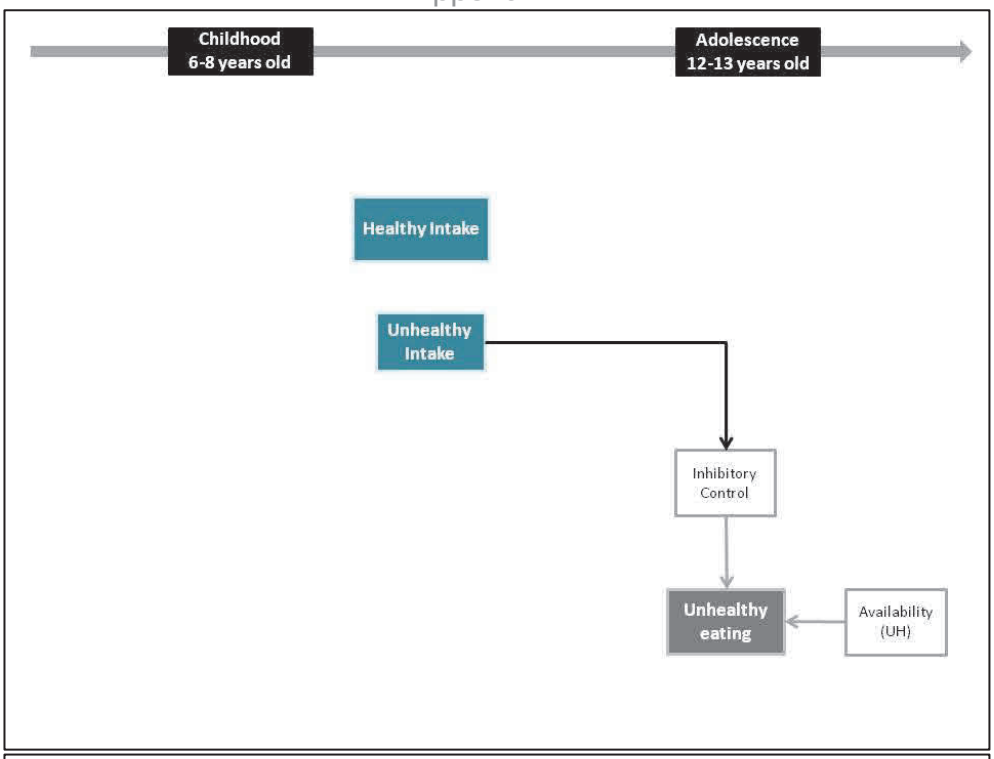

Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge (.01)
IMD (.07)
BMI(6-8y) (-.15)
Preferences (.03)
Healthy Intake (.19)
-.17
Trying Vegetables (.04)
Liking Vegetables (.07)
Unhealthy Intake (-.04)
Trying fruits (.02)
Liking fruits (.03)
Inhibitory Control
-.15
Healthy eating R² = .12
.19

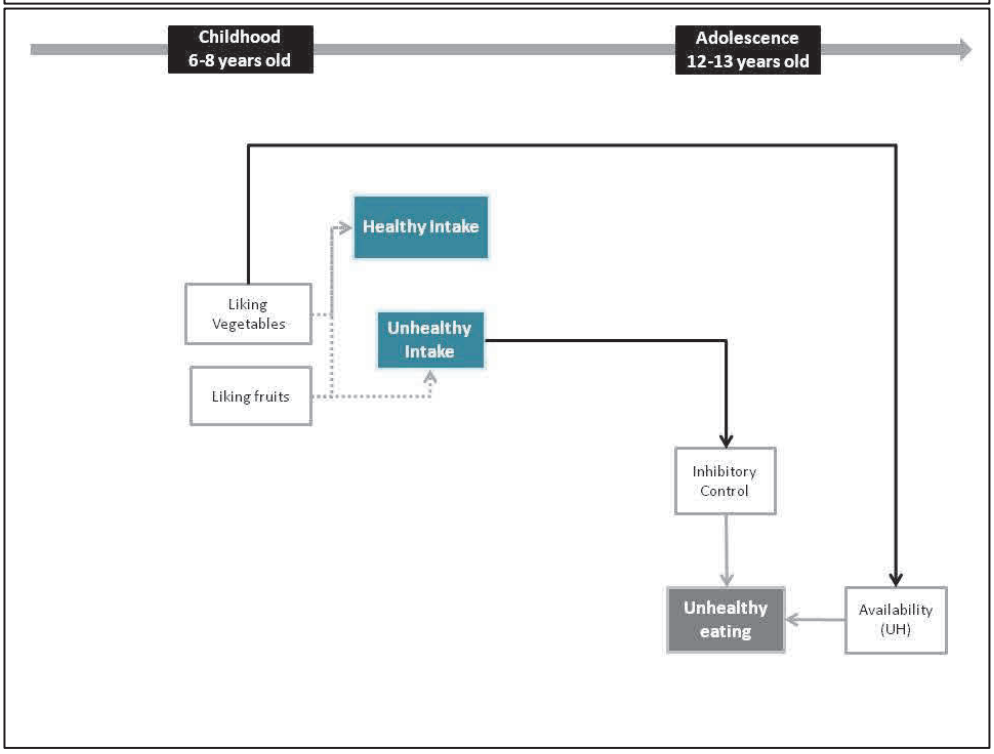
## Appendix K

- Model of childhood's eating behaviours and of adolescent's eating behaviours are based on the results of the chapter 2.1 and 3.3, respectively. Relationships within each of the models are represented by grey arrows.
- Each variable from the childhood model (left side) was related to all variables of the adolescence model (right side). However, only significant effects ($p<.05$) which are represented by black arrows were drawn in order to simplify the diagrams
- Path diagrams showing direct and indirect paths on adolescents' unhealthy eating. The arrow direction indicated the hypothesised direction of the causal flow and the standardized coefficients ($\beta$) are presented above each arrow.
- In the final model, the standardised total effect for each variable is the sum of the direct and indirect effects are shown under the variable name.

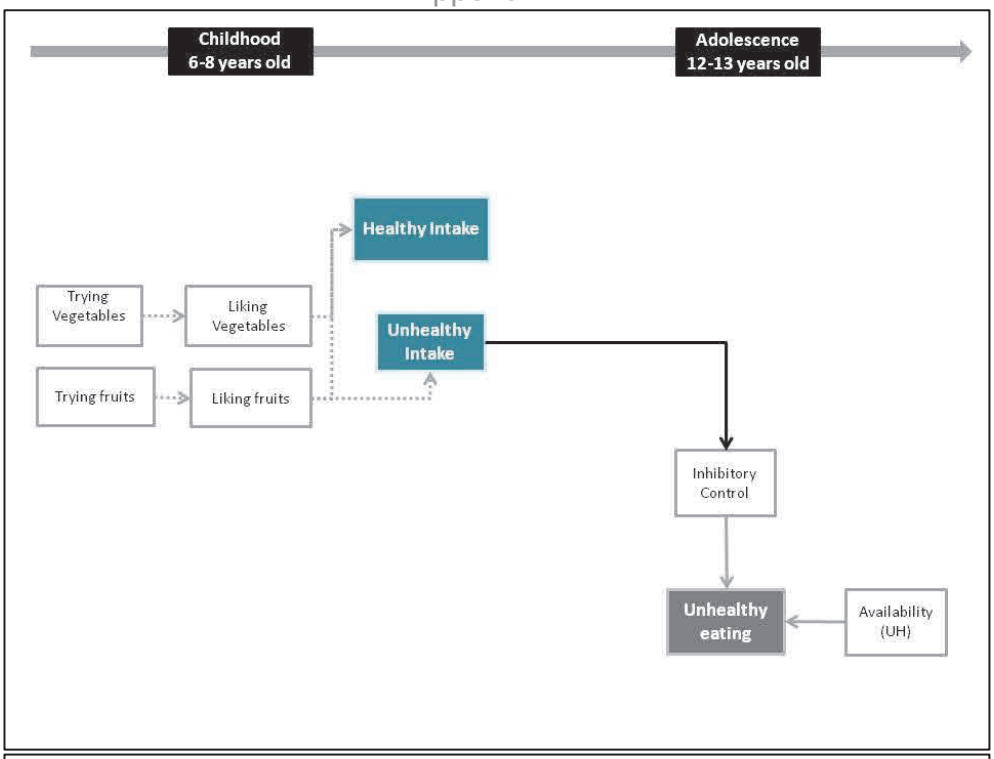


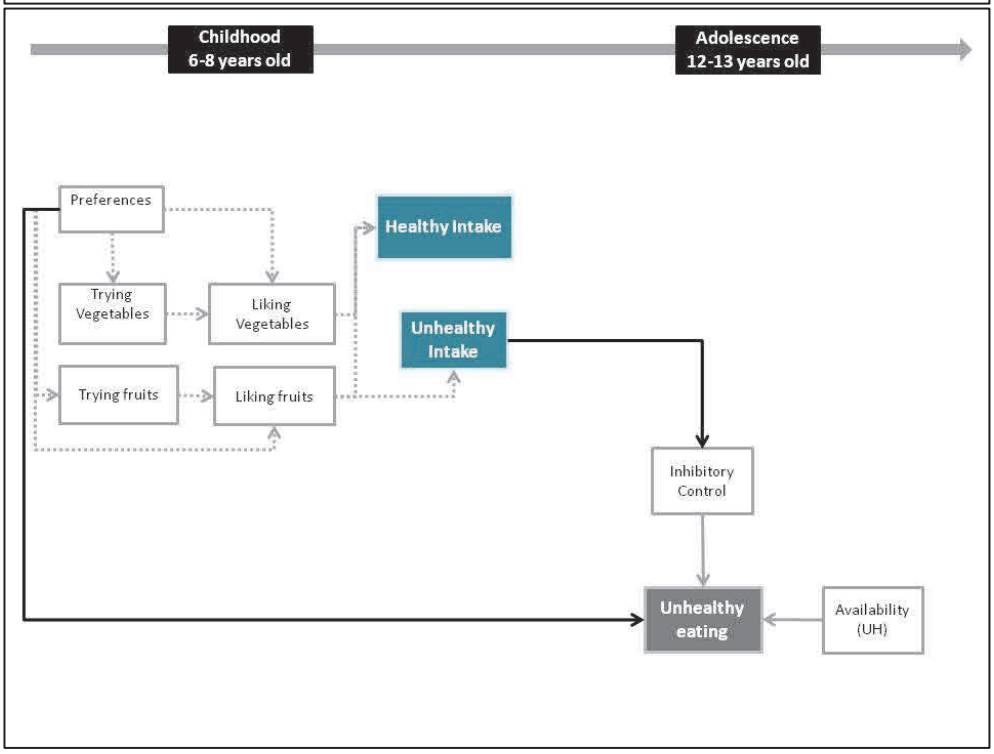
Appendix K


Childhood
6-8 years old
Adolescence
12-13 years old
Healthy Intake
Unhealthy Intake
Inhibitory Control
Unhealthy eating
Availability (UH)

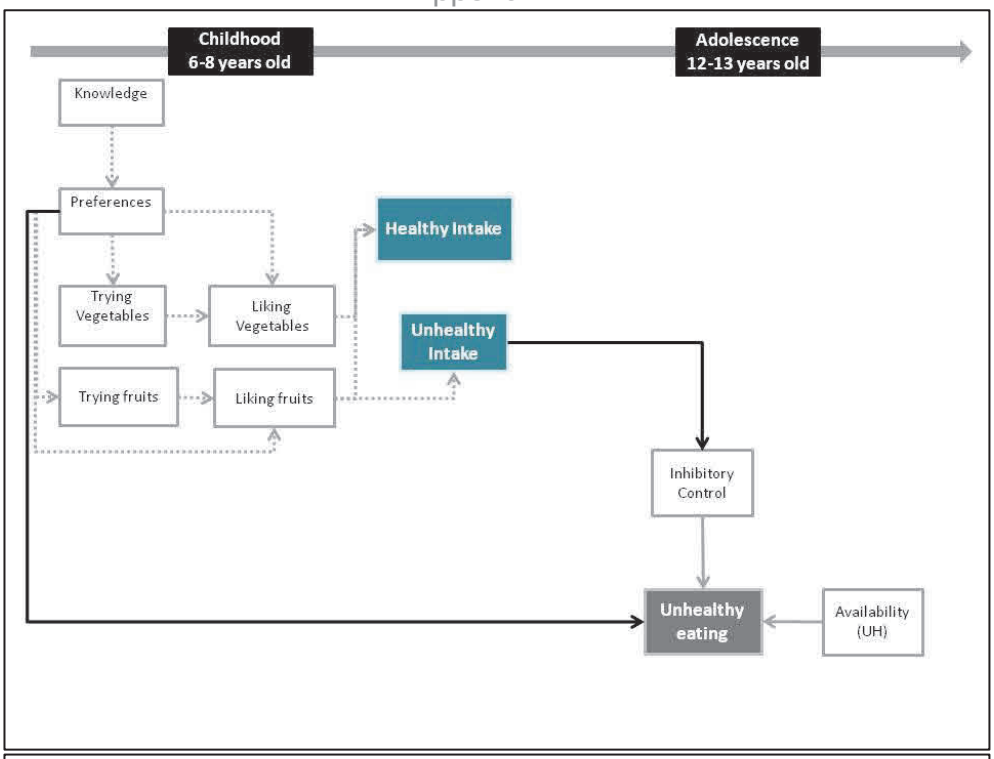

Childhood
6-8 years old
Adolescence
12-13 years old
Healthy Intake
Liking Vegetables
Unhealthy Intake
Liking fruits
Inhibitory Control
Unhealthy eating
Availability (UH)

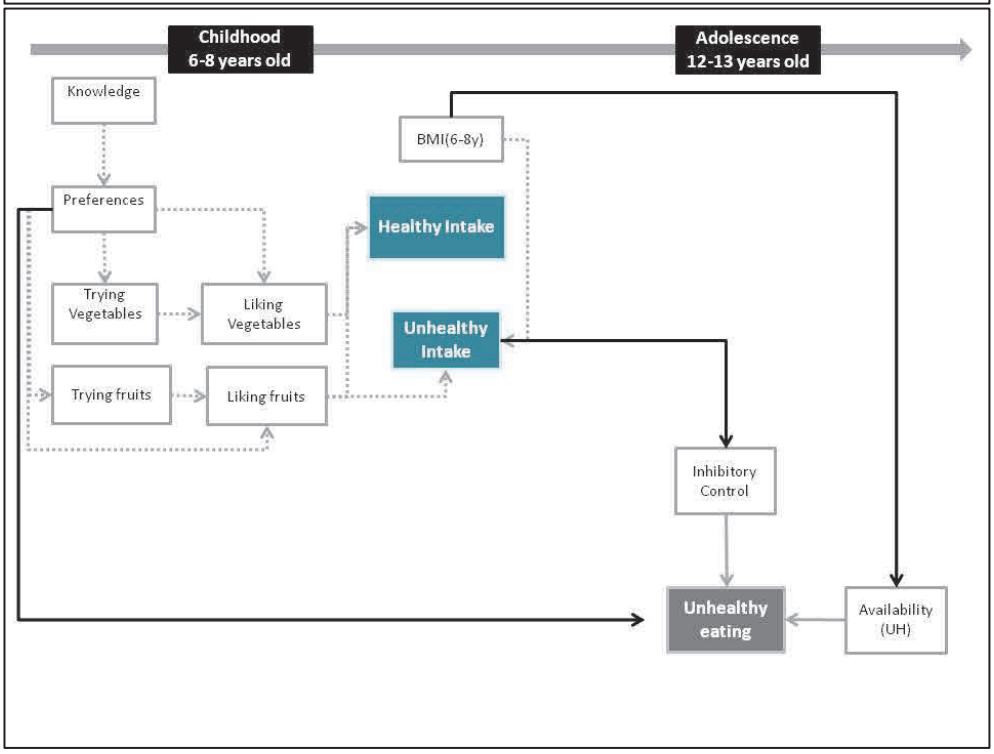
## Appendix K


Childhood
6-8 years old
Adolescence
12-13 years old
Healthy Intake
Trying Vegetables
Liking Vegetables
Unhealthy Intake
Trying fruits
Liking fruits
Inhibitory Control
Unhealthy eating
Availability (UH)

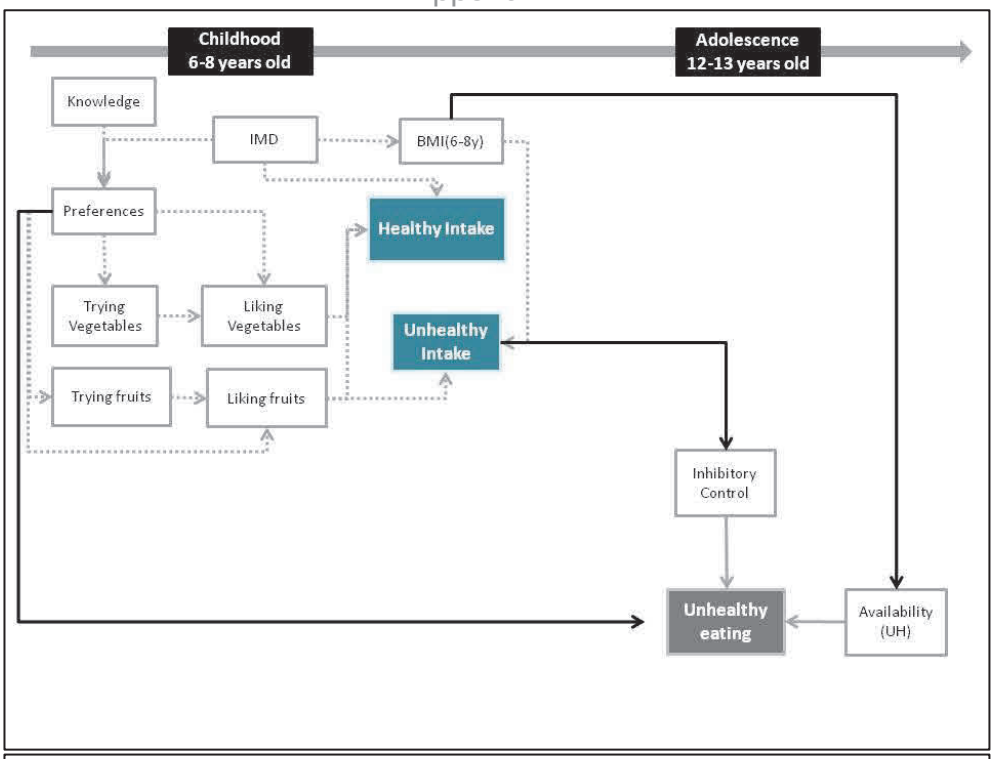

Childhood
6-8 years old
Adolescence
12-13 years old
Preferences
Healthy Intake
Trying Vegetables
Liking Vegetables
Unhealthy Intake
Trying fruits
Liking fruits
Inhibitory Control
Unhealthy eating
Availability (UH)

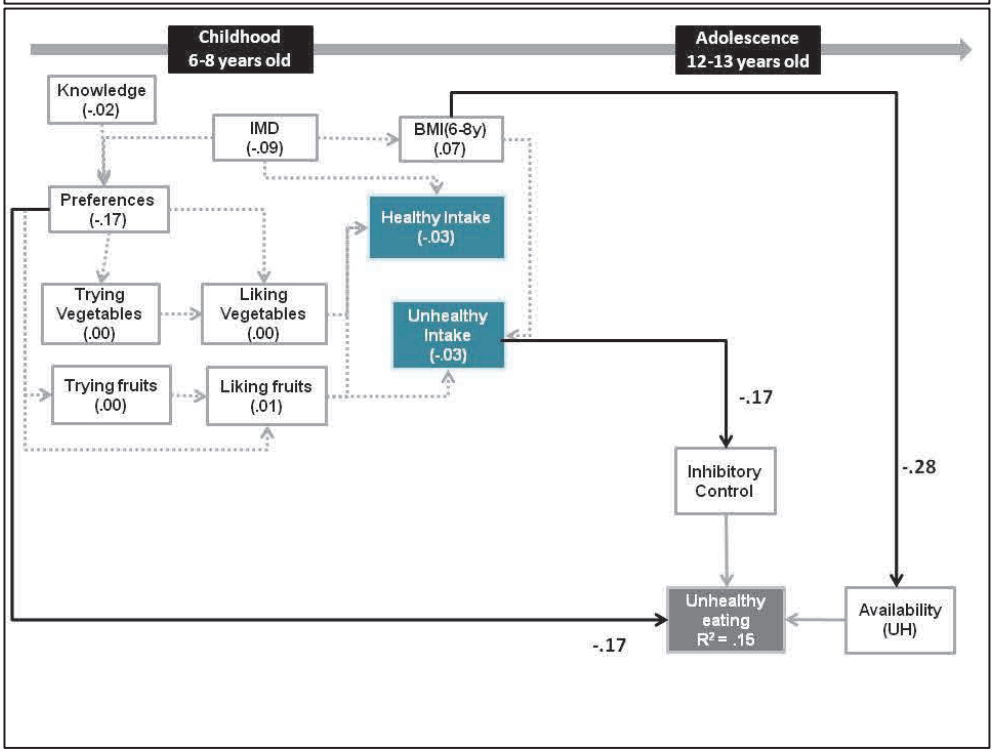
## Appendix K


Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge
Preferences
Trying Vegetables
Liking Vegetables
Trying fruits
Liking fruits
Healthy Intake
Unhealthy Intake
Inhibitory Control
Unhealthy eating
Availability (UH)


Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge
BMI(6-8y)
Preferences
Trying Vegetables
Liking Vegetables
Trying fruits
Liking fruits
Healthy Intake
Unhealthy Intake
Inhibitory Control
Unhealthy eating
Availability (UH)

## Appendix K


Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge
IMD
BMI(6-8y)
Preferences
Healthy Intake
Trying Vegetables
Liking Vegetables
Unhealthy Intake
Trying fruits
Liking fruits
Inhibitory Control
Unhealthy eating
Availability (UH)


Childhood
6-8 years old
Adolescence
12-13 years old
Knowledge (-.02)
IMD (-.09)
BMI(6-8y) (.07)
Preferences (-.17)
Healthy Intake (-.03)
Trying Vegetables (.00)
Liking Vegetables (.00)
Unhealthy Intake (-.03)
Trying fruits (.00)
Liking fruits (.01)
-.17
Inhibitory Control
-.28
Unhealthy eating R² = .15
Availability (UH)
-.17